FAA-E-2319b
AMENDMENT-2
September 27, 1972
SUPERSEDING
AMEND.-1, 3/7/72

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION SPECIFICATION

AIR TRAFFIC CONTROL BEACON INTERROGATOR

This amendment forms a part of FAA-E-2319b dated September 7, 1971 and supersedes FAA-E-2319b Amendment-1 dated March 7, 1972.

* Page 2, paragraph 2.1.1: Delete "FAA-D-638 Instruction Books, Electronic Equipment" and substitute "FAA-D-2494/1 and /2 Instruction Book Manuscripts Technical: Equipment and Systems, Requirements." *

Page 5, paragraph 3.1.2.2: Change "Remot" to "remote."

Page 5, paragraph 3.1.2.3: In line 8, change "output/output" to "output/input." At the end of the last sentence delete the period after required and add "for dual channel installation."

Page 11, paragraph 3.3.9.3: In line 4, change "(cap shall be attached to the test set by a chain)" to read "(cap shall be attached to interrogator by a chain)."

Page 12, paragraph 3.3.9.4.3: Delete the text following the semicolon in line 4, and substitute the following:

"When the inhibit gate circuit is enabled, all signals appearing at the three external modulation input jacks (3.3.9.4.1) shall be inhibited. The inhibit gate circuit shall be enabled by the beacon sync trigger and the starting time of the inhibit gate shall be adjustable from beacon sync time (zero delay) to 150 microseconds after beacon sync time.

At the end of the receiver STC gate (3.4.3.7.2), regardless of whether the STC gate is ON or OFF, the inhibit gate circuit shall be disabled, allowing the external signals to be processed."

Page 12, paragraph 3.3.9.5: Change item (b), pulse amplitude, to read "25.0 volts minimum across 75 ohms."

Page 13, paragraph 3.3.9.5: Last portion of paragraph, between first and second sentences, add:

"The base line voltage at all trigger output connectors shall be fixed at zero +0.2 -0.1 DC."

Page 14, paragraph 3.3.9.6: Delete the entire paragraph and substitute the following:

"3.3.9.6 Receiver video outputs.- Five separate and isolated video outputs, each meeting the requirements of 3.4.3.12 shall be available at BNC jacks in each interrogator channel on the rear surface of the receiver/transmitter unit. Each of these receiver outputs in each channel shall be routed to and switched by the control and transfer equipment so that video from the selected operating channel is available for remoting and driving external equipment. Each of the five outputs specified shall be designed to drive a properly terminated 75 ohm coaxial cable. A short circuit on the output of any or all of the receiver video outputs shall not derogate system performance."

Page 14, paragraph 3.3.9.6.1: Delete the entire paragraph and substitute the following:

"3.3.9.6.1 Buffered detector video output.- In addition to the five video outputs specified in paragraph 3.3.9.6, a separate, isolated, buffered detector output with the characteristics specified in paragraph 3.4.3.12.3 shall be provided at a BNC jack in each interrogator channel on the rear surface of the receiver/transmitter unit. An internal switch shall be provided to allow selection of a staggered or destaggered buffered detector video output. This video output shall be designed to drive a properly terminated 75 ohm coaxial line, and a short circuit on this output shall not derogate system performance."

* Page 18, paragraph 3.4.1.9: Delete the entire paragraph and substitute the following:

"3.4.1.9 Side lobe suppression.- The equipment shall include provisions for two types of side lobe suppression (SLS): basic three pulse SLS (3.2.9) and Improved SLS (3.2.9.1). The interrogation pulse pair (P1 and P3) and the SLS control pulse (P2) shall be generated by the same transmitter; circuitry shall be provided to accept and process external interrogation signals with SLS (see paragraph 3.3.9.4). Crystal diode type switches

shall be employed to accomplish switching of the transmitter pulses between the directional interrogation antenna and the omni-directional SLS antenna (see 3.4.1.9.2 and 3.4.1.9.3.1). It shall be possible by the use of a three position switch (labelled OFF, SLS and IMP SLS) to select either SLS or improved SLS operation. When this switch is in the OFF position, or upon failure of the RF switch or switches, radiation of the appropriate SLS or improved SLS pulse or pulses shall be inhibited, and the zero volt signal discussed in 3.3.9.4.2.1 shall be generated. This switch shall be located behind the front panel of the pulse mode generator or the receiver transmitter unit." *

Page 18, paragraph 3.4.1.9.1: In the first sentence, change "Mode SLS" to "Mode 4 SLS." In line 6, change "M4" to "Mode 4."

Page 19, paragraph 3.4.1.9.4: In the last sentence, change the word "revision" to "reversion."

Page 21, paragraph 3.4.2.1.1: Opposite (b) Duration, change to read "between 0.3 and 2.5 microseconds" and Opposite (c) Amplitude, change to read "between 5 and 50 volts peak across 75 ohms."

Page 21, paragraph 3.4.2.1.2: In the last sentence, change "trains per second" to "pulses per second."

Page 25, paragraph 3.4.3.2.2: After the word "An" in the first sentence, insert "easily accessible."

Page 26, paragraph 3.4.3.7: In the first sentence, change "7 dB" to "75 dB."

Page 26, paragraph 3.4.3.7.2: In line five, change "2500" to "3200."

* Page 27, paragraph 3.4.3.8: Delete entire paragraph and substitute the following:

"3.4.3.8 Interference rejection.- The receiver shall be capable of operating in the presence of continuous wave (CW) and modulated CW interference applied over the frequency range of the receiver bandwidth (3.4.3.4) as follows:" *

Page 27, paragraph 3.4.3.8.2: In line 2, change "(3.4.3.12.1)" to "(3.4.3.12.3)."

Page 27, paragraph 3.4.3.10.1: In line 5, change "buffer detector output (3.4.3.12.1)" to "nonquantized receiver video output (3.4.3.12.2)." In line 8, change "2500" to "3200." Add to end of paragraph: "Measurements shall be taken for both quantized and nonquantized video outputs."

Page 28, paragraph 3.4.3.10.1.2 (b): Amplitude, change to read: "Quantized and nonquantized outputs limited at 4 volts, adjusted to 2 volts."

Page 28: Add new paragraph:

"3.4.3.10.1.2.1 -23 dBm Signal.- Increase input signal amplitude of 3.4.3.10.1.1 (b) to -23 dBm and repeat 3.4.3.10.1; the output signal characteristics of 3.4.3.10.1.2 shall still apply except for pulse duration which shall not exceed 0.70 microsecond as specified in 3.4.3.12."

Page 28, paragraph 3.4.3.10.2.1 (c): Change "buffer detector" to "nonquantized video output."

Page 29, paragraph 3.4.3.10.2.2 (d): Change "buffer detector" to "nonquantized video."

Page 29, paragraph 3.4.3.10.2.3: Delete "and No. 1" from the paragraph title.

Page 29, paragraph 3.4.3.10.2.3 (d): Amplitude of pulses, change to read: "Quantized: full output and adjusted to 2 volts"; "Nonquantized: 0.8 volts minimum."

Page 29, paragraph 3.4.3.11: Last word in paragraph, change "micorsecond" to "microsecond."

Page 29 and 30, paragraph 3.4.3.12 and 3.4.3.12.1: Delete text of entire paragraphs and add the following paragraphs (3.4.3.12, 3.4.3.12.1, 3.4.3.12.2 and 3.4.3.12.3):

"3.4.3.12 Video outputs (quantized and nonquantized).- Three types of video shall be available from the receiver. These are (a) nonquantized staggered video, (b) nonquantized destaggered video and (c) quantized destaggered video. It shall be possible by means of mechanical solderless links to select and provide any combination of these three types of video to the five receiver video outputs (3.3.9.6). The pulse duration of the output pulses shall be not less than the duration of the incoming RF pulses and not greater than the incoming RF pulse duration plus 0.05 microseconds;

the pulse duration shall not exceed 0.70 microseconds for input signals (nominal pulse width 0.45 microseconds) whose amplitudes are greater than 24 dB above tangential sensitivity and less than or equal to -23 dBm. The video level at each of the five outputs shall be limited at 4.0 volts. The level of each of these five video outputs (3.3.9.6) shall be continuously adjustable between 1 and 4 volts (nominal operating level is 2.0 volts); overshoot and undershoot of the video pulses shall not exceed five percent of video pulse amplitude. The baseline of the video outputs shall be fixed at zero +0.2 -0.1 volts DC. No humps, video ringing, baseline modulation, parasitic oscillations, or other instabilities shall be present on the video outputs with any position of manual gain, STC and maintenance alignment controls. The fidelity and recovery characteristics requirements (3.4.3.10 to 3.4.3.10.2.3) shall be met for both quantized and nonquantized video."

"3.4.3.12.1 Quantized video output.- Video reply signals being processed through the quantizer circuitry shall be pulse width discriminated and pulse amplitude quantized. Received pulses of up to 0.20 microsecond duration shall be rejected, and received pulses of 0.3 microsecond duration or greater shall be accepted for quantizing. Rise time of the quantized pulses shall be between 0.05 and 0.1 microseconds and fall time of the quantized pulses shall be between 0.05 and 0.2 microseconds. The quantizing circuitry shall automatically determine the 6 dB (½ voltage) pulse width of each received pulse meeting the acceptance criteria, regardless of the pulse amplitude. An amplitude threshold level shall be provided to function automatically and with essentially optimum performance over the entire reply video range (video reply range is defined as all signals from tangential sensitivity up to -23 dBm). The threshold circuit shall automatically adjust to the noise level of the receiver such that not more than 30 pulses per second as averaged over an interval of 30 seconds are present at the quantized receiver output when no signals are applied to the receiver input, and the receiver is adjusted for input signals equal to tangential sensitivity. Optimum performance shall be considered achieved when the number of quantized output pulses from the receiver equal the number of RF input signals to the receiver, and the quantized noise does not exceed the limits specified. The thresholding shall be based on receiver noise and not incoming fruit density. All reply video pulses that meet the pulse width acceptance criteria and fall within the above amplitude range shall be quantized to an amplitude of not less than 4.0 volts."

"3.4.3.12.2 Nonquantized video output.- The overall gain of the receiver shall be such as to produce a noise level of ½ volt with all gain controls set 20% of angular travel below their maximum settings. The video limit level (peak voltage amplitude) shall be adjustable over a range of 1 to 4 volts while maintaining the noise amplitude level output constant, with a constant given setting of the IF gain (and video gain if used) control prior to video limiting. The noise level amplitude shall not decrease with advancement of the IF gain control beyond the normal operating position. Standard reply signals within the stated reply range (tangential sensitivity to -23 dBm) shall exhibit no degradation of rise and fall time;

rise time shall be between 0.05 and 0.1 microseconds and fall time shall be between 0.05 and 0.2 microseconds."

"3.4.3.12.3 Buffered detector output.- The characteristics of the buffered detector output (3.3.9.6.1) shall be essentially linear up to an output level of 4.0 volts. The output level shall be adjustable from 1.0 to 4.0 volts by means of an output control, and overshoot and undershoot of the video pulses shall not exceed five percent of the pulse amplitude. An average peak noise amplitude level of 0.5 volts shall be obtainable for normal settings of the IF gain control. The baseline of the buffer detector output shall be fixed at zero +0.2 -0.1 volts DC."

* Page 31, paragraph 3.4.4.1: Delete the entire paragraph and substitute the following:

"3.4.4.1 Power monitor.- The power monitor shall be adjustable to any power level within the range of the transmitter (3.4.1 to 3.4.1.3) amd shall employ calibrated sensitivity controls to adjust the monitoring levels to the established transmitter output. These controls shall have indicator dials and shall be sufficiently vernier to allow the monitor circuits to be accurately set to bracket the monitored parameters without ambiguities. The interrogate indicator lights on the front panel of the monitor unit (3.4.4) shall be lighted when the transmitted power level is within 0.7 dB of the adjusted monitor level, and a ground shall be applied to the interrogate readback control line (3.7.5) to activate the interrogate light at the indicator site. The interrogate lamps at the transmitter site shall be extinguished when the transmitted power deviates ±1.0 dB from the adjusted monitor level and a separate ground shall be initiated for remoting to the indicator site. This ground shall cause the interrogate light on the control box to flash on and off to indicate an interrogate power error (3.7.6.4.3). In addition, this ground shall be available at the control transfer unit for use by external equipments. An error shall be indicated if the power level of P1 or P3 on the directional antenna transmission line or the power level of P1 or P2 on the omni-directional antenna transmission line deviates beyond the ±1.0 dB tolerance. Test points shall be provided as appropriate for adjustment and maintenance of the monitor. Stability of the power monitor shall be such that the error indications are not falsely activated over the service conditions. When SLS and improved SLS (either one or both) are not being used, the appropriate monitor alarm shall be deactivated. This deactivation of the monitor alarm shall be accomplished by the SLS-IMP SLS switch referenced in 3.4.1.9." *

Pages 33 and 34, paragraph 3.4.5.5, 3.4.6.1, 3.4.6.3, 3.4.6.3.1 and 3.4.6.3.2: Change "12,000 feet" to "25,000 feet."

Page 37, paragraph 3.5.8.1: Change "volts route mean aquare" to "volts root mean square."

* Page 40, paragraph 3.7.3: Delete the entire paragraph and substitute the following:

"3.7.3 No control indication.- Indicator lamps at the transmitter site shall show when remote control is not possible because of any one or combination of the following: (a) the local/remote switch being in the local position, (b) any of the maintenance-operate switches being in the maintenance position, (c) any interlocks or local power supply switches being open and (d) when a defruiter no-control ground is present. For this purpose, two fixtures containing 60 W red lamps, one for each channel, shall be provided for installation in the transmitter building. These lamps shall be provided with labels designated "No Control Channel 1" and "No Control Channel 2." Terminals for providing voltage to illuminate these lamps shall be provided at an easily accessible terminal board in each associated interrogator channel. The no control lamp on the remote control box shall be lighted only when the non-selected channel is not available for use due to one or more of the above conditions (except condition (a)) existing; the no control lamp shall also light when the system is in local control."

Page 42, paragraph 3.7.6.4.6: Delete the entire paragraph and substitute the following:

"3.7.6.4.6 Mode selection.- The mode designator selector switches and mode selector switches shall occupy the three center positions of the switch layout. Mode designators X, Y, and Z shall be the top row. Modes 1, 3/A, and B shall be the middle row, and modes 2, C and D shall be the lower row, and the switches shall be labelled accordingly. A white indicator lens shall be associated with each switch. The selection of one mode designator and selection of one mode for remote override of the local mode designator/mode selection at the transmitter site in accordance with paragraph 3.4.2.4 shall be accomplished on not more than five control lines. Override of the mode designator and the mode selection shall not occur until both the mode designator and mode selection have been selected. When no remote control of these functions is activated, all five control lines shall be open (not grounded), and all lights shall be off. The indicator lights associated with these switches shall indicate the mode of operation as indicated by a readback ground from the transmitter site. These switches shall be spring loaded non-locking type interlocked such that it shall be possible for only one mode designator and one mode to be selected at any one time. It shall not be possible to activate all mode designators or all mode switches at any one time. The interlocking shall be such that a mode designator must be selected before a mode selection can be accomplished. A reset button (or bar) shall be provided below the mode designator/mode select group of switches. When this button is actuated, it shall cancel the mode designator and mode selected and shall reset the selector switches and circuitry before a new selection can be accomplished by pushbutton selection of any mode designator and mode desired. No one mode designator or mode selector shall have precedence over any other mode designator or mode selector." *

Page 44, paragraph 3.8.1.1: In the last sentence, change "AC voltmeter" to "DC voltmeter."

Page 46, paragraph 3.10, subparagraph (c): Delete last sentence and substitute the following:

"Two front panel ventilation plates (bottom and top) shall be provided with each cabinet rack."

* Page 46, paragraph 3.10, subparagraph (f): Add the following to end of subparagraph:

"Chafing of cables in the cable assemblies shall not occur when the equipment drawers are being "pulled-out" or "pushed-into" the equipment rack."

Page 47, paragraph 3.10.1: Delete the entire paragraph and substitute the following:

"3.10.1 Arrangement of equipment units.- Equipment units shall be arranged in each rack in the following top to bottom order:

(a) Ventilation panel
(b) Power panel
(c) Control transfer unit
(d) Blank panel - same size as control transfer unit
(e) Interrogator/receiver unit, low and high voltage power supply, and the monitor unit
(f) Pulse mode generator unit and the control unit
(g) Line driver unit
(h) Blank panels - C size; necessary number of these panels shall be provided to cover empty front cabinet space
(i) Ventilation panel - same size as the top ventilation panel."

Page 47, paragraph 3.12: Delete entire paragraph and substitute the following:

"3.12 Instruction book.- The instruction book shall be a Type A Equipment Instruction Book as referenced in FAA-D-2494/1; all applicable requirements of FAA-D-2494/1 and /2 shall apply including color shading."

Pages 47 and 48: Delete paragraphs 3.12.1, 3.12.1.1, 3.12.2 and 3.12.1.3 in their entirety. *

Page 50, paragraph 4.2: Under Receiver, Video Output, change "3.4.3.12; 3.4.3.12.1" to "3.4.3.12 through 3.4.3.12.3."

Page 52, paragraph 4.3: Under Receiver, Video Output, change "3.4.3.12; 3.4.3.12.1" to "3.4.3.12 through 3.4.3.12.3."

Page 53, paragraph 4.4: Under Receiver, Video Output, change "3.4.3.12; 3.4.3.12.1" to "3.4.3.12 through 3.4.3.12.3."

Page 53, paragraph 4.4.1: Delete the title and text in its entirety and substitute the following:

"4.4.1 24 hour burn-in test.- All production equipments shall undergo a 24 hour burn-in test at the completion of production testing. After a 10 minute warm up period the equipment shall be adjusted and aligned for optimum performance and test measurements taken and recorded to verify all features are functioning properly. The equipment shall then operate for 24 hours during which time only front panel controls may be manipulated. At the end of the 24 hour operating period, the test measurements shall be repeated and recorded. All observations of malfunctioning or instability in the equipment shall be recorded on test data sheets and will serve as a log or history of the test. The Government representative/s shall be permitted to make any number of entries in the combined Government-contractor log even if not concurred with by representatives of the contractor. The equipment shall not be de-energized more than one time during the 24 hour time period and the total outage shall not exceed 30 minutes; if either or these are exceeded, the 24 hour burn-in test shall be repeated. All specification requirements specified herein shall be met during this test."

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FAA-E-2319b

September 7, 1971

SUPERSEDING
FAA-E-2319a, 12/18/70

DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION SPECIFICATION

AIR TRAFFIC CONTROL BEACON INTERROGATOR

1. SCOPE

1.1. Scope.- The equipment specified herein is the interrogator portion of the ground station of the Air Traffic Control Radar Beacon System (ATCRBS). The interrogator is comprised of two separately controlled transmitter/receiver channels with provisions for inter-channel switching of antenna and control functions such that either a dual channel or single channel configuration may be employed as desired. Other salient features include provisions for side lobe suppression, processing of external Mode 4 interrogation signals from the AN/GPA-124, monitoring, video remoting, and remote control. The interrogator is normally located at a primary radar site and operates in association with the primary radar. The beacon antennas are mounted on the radar antenna, the system pretrigger is provided by the radar and beacon video is displayed on the radar PPI. The beacon system is capable of internally generating its own system trigger and may be operated as an independent system with the addition of an antenna pedestal, servo system and PPI display unit.

2. APPLICABLE DOCUMENTS.

2.1 FAA documents.- The following FAA specifications and standards, of the issues specified in the invitation for bids or request for proposals, form part of this specification.

2.1.1 FAA specifications.-

FAA-D-638	Instruction Books, Electronic Equipment
FAA-E-163b	Rack, Cabinet and Open Frame Types with Amendment-2 and Specification Change 3
FAA-E-2235	Transmitting Set, Coordinate Data, AN/FYQ-47, 48 and 49
FAA-E-2261A	Radar Beacon Performance Monitor Equipment
FAA-G-2100/1	Electronic Equipment, General Requirements; Part 1, Basic Requirements for all Equipments
FAA-G-2100/2	Part 2, Requirements for Equipments Employing Electron Tubes
FAA-G-2100/3	Part 3, Requirements for Equipments Employing Semiconductor Devices
FAA-G-2100/4	Part 4, Requirements for Equipments Employing Printed Wiring Techniques
FAA-G-2100/5	Part 5, Requirements for Equipments Employing Microelectronic Devices

2.1.2 FAA standards.-

ATCRBS	U. S. National Standard for IFF MARK X (SIF)/ Air Traffic Control Radar Beacon System Characteristics
FAA-STD-013A	Quality Control Program Requirements

(Copies of this specification and other applicable FAA specifications, standards, and drawings may be obtained from the Contracting Officer in the Federal Aviation Administration office issuing the invitation for bids or request for proposals. Requests should fully identify material desired, i.e., specification, standard, amendment and drawing numbers, and dates. Requests should cite the invitation for bids, request for proposals, or the contract involved or other use to be made of the requested material.)

2.2 Military documents.- The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issue in effect on the date of invitation for bids or request for proposals shall apply.

MIL-C-3098	Crystal Units, Quartz, General Specification for
MIL-T-21038	(SHIPS) Transformer, Pulse
MIL-STD-461	Electromagnetic Interference Characterics Requirements for Equipments
MIL-STD-470	Maintainability Program Requirements (For Systems and Equipments)
MIL-STD-471	Maintainability Demonstration
MIL-STD-756A	Reliability Prediction Procedures
MIL-STD-781B	Reliability Tests
MIL-STD-785A	Requirements for Reliability Program (For Systems and Equipments)
MIL-HDBK-472	Maintainability Prediction
AD 821 640*	RADC-TR-67-108, RADC Reliability Notebook

(Single copies of Military specifications may be requested by mail or telephone from U. S. Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120 (for telephone requests call 215/697-3321, 8 a.m. to 4:30 p.m., Monday through Friday). Not more than five items may be ordered on a single request; the Invitation for Bid or Contract Number should be cited where applicable.)

*Copies of this document can be obtained from the National Technical Information Service (NTIS), Operations Division, Springfield, Virginia 22151.

2.2.1 Classified military documents.-

DOD AIMS 66-523B	AN/GPA-124 Coder - Decoder Group
DOD AIMS 65-1000	Technical Standards for the ATCRBS/IFF/Mark XII System (AIMS)

Copies of these documents may be obtained from:

L. G. Hanscom Field
Bedford, Massachusetts 01730
Attn: DOD AIMS/TRACALS Special Project Office, DCTC

3. REQUIREMENTS.

3.1 Equipment and services to be furnished by the contractor.- The contractor shall furnish the quantity of dual channel interrogator systems comprised of equipment groups as specified in the contract. Any item or part necessary for proper operation of the units of this equipment in accordance with the requirements of this specification shall be incorporated even though that item or part may not be specifically provided for or described herein. All features required to meet performance requirements, such as shock mounting, controls, indicator lamps, overload protection devices, meters, test points, switches, etc., shall be incorporated even though the feature may not be specifically provided for or described herein. All necessary facilities, parts, and hardware, including receptacles, mating connectors, cabling (wiring), adapters, and outlets shall be provided. Each interrogator system shall be complete in accordance with all specification requirements and each equipment group shall include the major items tabulated under subparagraphs below (all other items not listed below but required in each equipment group for system operation, as required in this specification, shall also be furnished.) Each interrogator system shall be comprised of two separate equipment racks which shall contain all equipment units, except for the optional line compensator group (3.1.2.1) and optional control box group (3.1.2.2). An equipment rack (3.10) shall be provided for each channel of the interrogator equipment. Sufficient space shall be available in each rack for mounting of units required for dual channel operation such as the control transfer units with their associated power supplies.

3.1.1 Transmitter site equipment.-

3.1.1.1 Interrogator group.-

1 Set - Control transfer equipment including the following:

- 2 each - Control transfer unit (main and spare), each including its own control circuit power supply.

1 Set - Interrogator equipment, dual channel, each channel including the following:

- 1 each - Receiver/Transmitter Unit
- 1 each - Pulse mode generator unit
- 1 each - Interrogator power supply
- 2 each - RF probe assembly for interrogator monitor
- 1 each - Antenna transfer unit, including dummy loads
- 1 each - Control unit
- 1 each - Control circuit power supply

1 Set - Special tools for maintenance

1 Set - Circuit card extender boards

System instruction books (as specified in the contract)

System trouble-shooting manuals (as specified in the contract)

3.1.1.2 Monitor group (option).-

2 each - Interrogator monitor unit (channel 1 and channel 2)

3.1.1.3 Line driver group (option).-

2 each - Line driver unit (channel 1 and channel 2)

3.1.2 Indicator site equipment.-

3.1.2.1 Line compensator group (option).-

2 each - Line compensator unit (main and spare)

3.1.2.2 Control box group (option).-

2 each - Remot control box (main and spare)

3.1.2.3 Channel configuration and cable requirements.- Each channel of the interrogator system, as delivered, shall include one control transfer unit, and when required by the contract, one monitor unit (3.1.1.2) and one line driver unit (3.1.1.3). The units shall be installed in each channel rack in accordance with paragraph 3.10. All power, control, video, trigger and RF cable required to interconnect the units within a rack and to interconnect the power, control video, trigger and RF output/input functions of the units from within one rack to output/output terminals within another rack shall be furnished. Output/input terminals shall be provided in each equipment rack for interfacing a single channel interrogator with either RML or land line remoting facilities. A complete set of intra-connecting cables, complete with all required connectors and terminal lugs, shall be furnished for each interrogator channel even though some of these cables may not be required.

3.1.2.3.1 Inter-channel cabling.- All inter-channel, inter-connecting cable shall be furnished in bulk form, and shall not be prefabricated. A continuous length of each type of cable required to interconnect the system in a dual channel configuration, with channel 1 the central point, shall be furnished. The total amount of bulk cable furnished shall be based upon individual cable lengths between channels of 50 feet each. All connectors, terminal lugs, cable clamps, etc., required to complete a dual channel installation, except for external cabling to Government owned power panels, antennas, etc., shall be provided in bulk lot form for each dual channel interrogator system.

3.1.3 Services and test equipment.- The contractor shall furnish all services and test equipment required in connection with testing and establishing proof of compliance with specification requirements.

3.1.4 Blowers and vents.- All blowers and vents necessary for the proper ventilation of the equipment shall be provided and installed. Each cabinet requiring forced air ventilation shall contain its own blower system, and shall require no external ducts. Should forced air cooling of the transmitter tube or tubes be required, a separate blower shall be provided for this purpose and shall be mounted in close proximity to the tube. The blower shall be so connected that power is applied simultaneously with the filament voltage to the tube; an airflow interlock switch shall be employed which will remove filament and high-voltage power from the tube in case of failure of the forced air cooling.

3.1.5 Nameplates.- Each interrogator channel shall be provided with a nameplate which shall be mounted on the front of the equipment rack. This nameplate shall have the following title information:

ATCBI-(*)
Air Traffic Control
Beacon Interrogator
(*) Number to be assigned at time of nameplate approval.

In addition, each equipment rack, unit, and major subassembly shall have a nameplate. All nameplates shall be in accordance with the requirements of Paragraphs 1-3.13 to 1-3.13.3 of FAA-E-2100/1.

3.2 Definitions.-

3.2.1 Beacon sync trigger.- The beacon sync trigger is the master trigger in the pulse mode generator circuitry. It is the trigger at the output of the countdown circuit when a primary radar pre-trigger is employed or when the pulse mode generator (3.4.2) self trigger function is selected.

3.2.2 Pulse measurements.- The following definitions apply when making pulse measurements; reference is made to Figure 1. These definitions supersede pulse definitions in FAA-G-2100/1, paragraphs 1-3.2.14 through 1-3.2.17.

3.2.2.1 Pulse amplitude.- The pulse amplitude is defined as the amplitude "A" of the equivalent rectangular pulse.

3.2.2.2 Pulse duration.- The pulse duration is defined as the duration "t" of the equivalent rectangular pulse and is the duration of the actual pulse between the 0.5A points on the leading and trailing edges.

3.2.2.3 Pulse rise time.- The pulse rise time is defined as that portion of the total rise time for the pulse to change from 0.1A to 0.9A.

3.2.2.4 Pulse decay time.- The pulse decay time is defined as that portion of total decay time required for the pulse to change from 0.9A to 0.1A.

3.2.2.5 Pulse spacing.- Measurements of spacing between pulses and other time measurements made with a pulse as reference shall be made with reference to the instant the leading edge of each pulse reaches 50 percent (point "h", Figure 1) of the pulse amplitude.

3.2.2.6 Pulse slope.- The pulse slope shall be defined as the difference between the amplitude of the pulse when the leading edge changes from a substantially linear slope to a substantially non-linear slope (Figure 1, point "b") and its amplitude at the instant when the trailing edge of the pulse changes from a substantially non-linear slope to a substantially linear slope (Figure 1, point "j"). Slope shall be expressed in terms of percent of pulse amplitude.

3.2.2.7 Pulse train droop.- Pulse train droop is defined as the ratio of the amplitude of the last pulse in a pulse train to the amplitude of the first pulse in the train (Figure 1, Amplitude "A").

3.2.3 Interrogation modes.- The interrogation modes consist of two transmitted pulses designated P1 and P3. The interval between P1 and P3 determines the mode of interrogation. Interrogation mode characteristics are described in the U. S. National Standard for the IFF MARK X (SIF)/Air Traffic Control Radar Beacon Systems Characteristics.

3.2.4 Mode interlace.- Mode interlace refers to a type of operation whereby transmitting time is divided between two or more interrogation modes.

3.2.5 Reply codes.- The reply codes contain two framing or bracket pulses, from zero to a maximum of 13 information pulses, and a special position identification (SPI) pulse. The reply pulse train in response to a particular interrogation mode shall be at the same repetition rate and synchronous with interrogations on that mode. The reply code characteristics are described in the U. S. National Standard for the IFF MARK X (SIF)/Air Traffic Control Radar Beacon Systems Characteristics.

3.2.5.1 Reply code identification.- Reply codes are classified as common system discrete reply codes and nondiscrete reply codes.

3.2.5.1.1 Common system discrete reply codes.- Common system discrete reply codes use the framing pulses plus the A, B, C, and D pulse positions and the SPI pulse. This provides 4096 reply codes and the capability of adding the SPI pulse to each reply code. The discrete reply code number consists of four digits. Each digit may have a value of 0 through 7. The first (most significant) digit consists of the sum of the subscripts of the "A" pulse positions employed, the second digit consists of the sum of the subscripts of the "B" pulse positions employed, the third digit consists of the sum of the subscripts of the "C" pulse positions employed, and the fourth digit consists of the sum of the subscripts of the "D" pulse positions employed. Identification may be accomplished by transmission of the SPI pulse, 4.35 ± 0.1 microseconds after the second framing pulse, or by the repetition of the entire code train with the first framing pulse of the second pulse train following 4.35 ± 0.1 microseconds after the second framing pulse of the first train. Assignment of reply codes not employing any of the "C" and "D" pulse positions to a "nondiscrete" code category leaves 4032 discrete reply codes for air traffic control aircraft identification.

3.2.5.1.2 Common system nondiscrete reply codes.- Common system nondiscrete reply code structure is the same as the discrete reply code structure except that the "C" and "D" pulse positions are not employed. This provides 64 four-digit codes, with the last two digits always zero.

3.2.6 Fruit.- The term "fruit" as used herein is defined as detected video pulses at the beacon receiver output which are not in synchronism with the interrogation period.

3.2.7 Defruit.- "Defruit" is a term referring to a technique of interference suppression wherein a beacon reply is checked for synchronism with the beacon interrogation rate to allow rejection of non-synchronous beacon replies (fruit).

3.2.8 Second-time-around targets.- Second-time-around targets are synchronous replies from transponders located at slant ranges which exceed the system maximum display range and tend to erroneously appear on the display as close-in beacon targets.

3.2.9 Three-pulse side lobe suppression (SLS).- Three-pulse SLS is a technique for suppression of transponder replies to interrogations by the side lobe radiation of the directional antenna. The interrogation mode RF pulse pair, P_1 and P_3, are radiated by a rotating directional antenna and the RF control pulse, P_2, is radiated by an omni-directional antenna. The P_2 pulse occurs at a specific time interval after the first interrogation pulse, P_1, and at a fixed amplitude ratio with P_1. The airborne radar beacon transponder contains circuitry for amplitude comparison and pulse spacing recognition of pulses P_1 and P_2 and for suppression of replies to side lobe interrogations.

3.2.9.1 Improved side lobe suppression (Improved SLS).- The operation of improved SLS is basically the same as three-pulse SLS, except that P_1 is transmitted from both the directional and omni-directional antennas instead of only the directional antenna. This enables suppression of transponder replies to reflected-path interrogations by providing a direct-path P_1 signal for time and amplitude comparison with P_2.

3.2.10 Unit.- The word "unit" as used herein denotes a completely assembled and wired panel assembly, chassis assembly, a combination chassis-panel assembly or an electromechanical assembly.

3.2.11 Ripple voltage.- Ripple voltage is referred to as the peak-to-peak value of a simple or complex waveform consisting of power line frequency components and harmonics thereof, and synchronous and repetitive non-synchronous transients.

3.3 Basic design requirements.- The basis of overall system design shall be the achievement of maximum operational reliability, availability and maintainability. The selection and layout of components in the design of units, cabinets, junction boxes and cables, including adequate provisions for accessibility and conservative ratings of components, shall not be compromised in order to limit space and weight. The equipment shall be designed so that all alignment, adjustment and maintenance, except replacement of heavy components such as transformers, can be performed in a straight forward manner by only one technician. With transmitter high voltage turned off, all triggered equipment such as pulse mode generator, receiver sensitivity time control (STC) and trigger outputs shall remain in normal triggered operating conditions. The connection and removal of test equipment supplemental to normal equipment operation, such as monitor synchroscopes, power measuring equipment, etc., shall not result in deteriorated system performance. Opening the access doors of equipment cabinets shall not deteriorate or be critical to proper system performance.

3.3.1 Power source.- The interrogator equipment shall operate from a single-phase primary AC power source. The design center values (1-3.2.21 FAA-G-2100/1) shall be 120V 60 Hz. The design center value for D.C. control voltage shall be 24 volts (modifies 1-3.2.21 of FAA-G-2100/1). A main power circuit-breaker shall be provided for each channel with interconnection provisions such that either of the individual channel circuit-breakers may be used as the main power control for the system when a dual channel configuration is used.

3.3.2 Service conditions.- The service conditions (see paragraph 1-3.2.23, FAA-G-2100/1) for AC line parameters shall be 120 VAC and for ambient conditions shall be Environment II.

3.3.3 Vacuum tubes.- Vacuum tubes in accordance with FAA-G-2100/2 may be used in the final RF amplifier stages of the interrogator transmitter. No other use of vacuum tubes shall be made without written permission from the contracting officer.

3.3.4 Solid state devices.- In keeping with design objectives and requirements as stated herein, maximum practical use of semiconductor devices (in accordance with FAA-G-2100/3) and microelectronic devices (in accordance with FAA-G-2100/5) shall be made where improved operation as well as space saving will result.

3.3.5 Printed wiring and printed circuit boards.- Printed wiring and printed circuit boards shall be in accordance with FAA-G-2100/4. Plug-in subassemblies shall be of the printed circuit type which can be removed without need of unsoldering. Test points shall be easily accessible without withdrawing the board from its installed position. Board extenders allowing access to both sides of the board shall be provided to connect the printed circuit board into its normally connected circuitry for servicing.

3.3.6 Modularity.- Maximum use of modular design techniques shall be employed in the design and fabrication of the individual units (see paragraph 3.1.1.1) making up the interrogator group. Assemblies and subassemblies shall utilize plug-in techniques and shall be easily replaceable to permit rapid interchange with spare assemblies. All assemblies shall be mechanically secured for retention in their proper position.

3.3.7 Modular design.- Each assembly or subassembly shall provide a complete circuit function(s) with readily accessible test points. Care shall be exercised to assure that the circuits are reliable and utilize the best heat transfer techniques available.

3.3.8 Reversability. - The equipment shall incorporate features such that it is mechanically or electrically impossible to incorrectly install its modules, circuit card assemblies, and subassemblies. Keying to meet this requirement shall be accomplished in a manner such that a minimum of different types of extender boards shall be required to service all circuit card assemblies and subassemblies.

3.3.9 Provisions for ancillary equipment.- Provisions shall be incorporated in the design and fabrication of the interrogator system and its control equipment for operation with other portions of the ATCRBS ground station equipment as covered in the following subparagraphs (3.3.9.1 thru 3.3.9.9).

3.3.9.1 Interface with antennas.- To provide for interface with external ATCBI-directional and omni-directional (SLS) antennas, two RF output jacks, female type HN, UG-61A panel jacks, shall be furnished and installed on the top of each interrogator channel rack. These jacks shall be located on a line perpendicular to the rear surface of the rack equidistant from each side of the rack, centered 3½ inches apart. The center of the rear connector shall be located 8 inches from the rear edge of the rack. The RF output jacks shall be connected to the directional and omni-directional outputs of the antenna transfer unit (3.4.5.2) in each channel. Identification plates labeled "DIRECTIONAL" and "OMNI-DIRECTIONAL" shall be provided and installed adjacent to the appropriate jacks.

3.3.9.2 Defruiter power.- A 600-volt ampere, 120-volt AC circuit, controlled by the interrogator/receiver main power control, shall be provided in each interrogator channel. This circuit shall terminate at readily accessible terminals so that it may be connected to Government-furnished defruiter equipment. This circuit need not be regulated.

3.3.9.2.1 Defruiter controls.- Readily accessible and suitably designed terminals shall be provided in each interrogator channel to interface with the following defruiter control, readback, and no-control functions.

	Function	Type Circuit
(a)	Defruit ON-OFF select	ground to defruiter for "ON"
(b)	Defruit read-back	ground from defruiter
(c)	Defruiter no-control	ground from defruiter
(d)	Defruiter no-control	AC from interrogator (interlock)
(e)	Defruiter no-control	AC return to interrogator
(f)	Ground	Common for control circuits

The AC no-control circuitry may be omitted if interrogator design does not require this circuitry for its operation.

3.3.9.3 Radar trigger inputs.- Each channel of the interrogator equipment shall be provided with two separate BNC input jacks for accepting radar triggers. Each input jack shall be provided with a 75 ohm terminating BNC cap (cap shall be attached to the test set by a chain) so the terminating cap may be connected or disconnected as required. One of the jacks shall accept the radar pretrigger as required in paragraph 3.4.2. The other jack shall accept the radar zero range trigger pulse required for monitor operation (3.4.4.2). With the 75 ohm terminating resistor disconnected, the input impedance at each input jack shall be 20,000 ohms. For dual channel operation of the interrogator system, trigger inputs shall be interconnected by high impedance bridging from one channel to the other by use of "TEE" connectors. The last channel on the line shall be terminated in 75 ohms. Input trigger characteristics shall be as specified in paragraph 3.4.2.1.1.

3.3.9.4 Interface with the AN/GPA-124 and the AN/FYQ-47.- Each interrogator channel shall interface properly with the AN/GPA-124 (see Specification DOD AIMS 66-523B) and the AN/FYQ-47 (see Specification FAA-E-2235). Three electrically isolated modulation input jacks shall be provided in each interrogator channel for accepting and transmitting Decoy Interrogation Signals, Mode 4 challenge signals and Mode 4 side lobe suppression (SLS) signals from the AN/GPA-124. Each signal, on a separate line, shall be routed to and switched by the control and transfer equipment. These signals will be externally time related to the SIF pretrigger so their occurrence will always be prior to transmission of the normal internal interrogation signals occurring on the same prf. Mode triggers, comprised of P1 and P3, (3.3.9.5.2) shall be provided to the AN/FYQ-47 for beacon reply processing. A non-sensitive mode trigger occurring at P3 time (3.3.9.5.2.1) shall be provided to the AN/GPA-124 as a trigger source.

3.3.9.4.1 External signals for transmitter modulation.- The transmitter in each channel shall be provided with three electrically isolated BNC jacks for accepting the three external modulation signals (3.3.9.4) from the AN/GPA-124. Each input jack shall be provided with a 75 ohm terminating resistor and a disconnect strap so the resistor may be strapped in or disconnected as required. The input impedance of each input circuit shall be 20,000 ohms with the terminating resistor disconnected. Characteristics of the three external modulation signals (decoy interrogations, Mode 4 Challange and Mode 4 SLS) shall be as specified in AN/GPA-124

specification, DOD AIMS 66-523B and the Technical Standards for the ATCRBS/IFF/MARK XII System (AIMS), DOD AIMS 65-1000. The Decoy Interrogations and Mode 4 Challenge shall be routed to the directional antenna jack and the Mode 4 SLS pulse (P-5) shall be routed to the omni-directional antenna jack.

3.3.9.4.2 Mode 4 side lobe suppression (SLS).- An internal SLS gating signal shall be generated from the fourth sync pulse (P4) of the Mode 4 Challenge and shall be continuously adjustable by an internal control from at least 1.0 to 2.5 microseconds in pulse spacing after the P4 sync pulse. The leading edge of the internally generated SLS gating signal shall be used to switch the RF switch or switches at the proper time to route the Mode 4 SLS pulse (P5) only to the omni-directional antenna jack.

3.3.9.4.2.1 Mode 4 operate/failure signal from SLS RF switch.- The RF switch in each channel of the interrogator shall provide an operate/failure and off signal for the AN/GPA-124 that is routed to and switched by the control and transfer equipment. Characteristics of the signal shall be as follows:

a.	Polarity	Positive
b.	Amplitude	12 volts, operate 0 volts, RF switch failure and OFF position
c.	Duration	Continuous
d.	Termination	10,000 ohms or greater

When the RF switch (or switches) is ON and functioning properly, the 12 volt signal shall be available to the AN/GPA-124. When the RF switch (or switches) is OFF or has failed, the zero volt signal shall be available to the AN/GPA-124.

3.3.9.4.3 External modulation inhibit gate.- An inhibit gate circuit shall be provided in each channel of the interrogator to prevent possible transmission of undesired signals appearing at the external modulation input jacks; SIF interrogations from the AN-GPA-124 shall also be inhibited. When enabled by the output trigger from the trigger delay circuit (3.4.2.1.4), minimum delay shall be 40 microseconds ahead of P3 pulse, all signals appearing at the three external modulation input jacks (3.3.9.4.1) shall be inhibited. At the end of the receiver STC gate (regardless of whether it is ON or OFF) the inhibit circuit shall be disabled, allowing the external signals to be processed.

3.3.9.5 Trigger outputs.- The interrogator shall provide various trigger outputs for remoting to the indicator site and as inputs to external equipment at the transmitter site. The characteristics of all output triggers shall be as follows:

(a) Polarity - positive
(b) Pulse amplitude - adjustable, 10 to 50 volts across 75 ohms
(c) Pulse duration - 1 $\pm$ 0.5 microseconds
(d) Pulse rise time - 0.1 microsecond maximum

(e) Pulse decay time - 0.4 microsecond maximum
(f) Pulse jitter, with respect to the radar input trigger - 60 nanoseconds maximum

All trigger outputs shall have a source impedance of 75 ohms or less and shall be designed to drive a properly terminated 75 ohm coaxial cable. Each output shall be sufficiently isolated from other interrogator circuitry such that improper terminating impedances, including shorts or opens at one or more output jacks, shall not affect interrogator operation. All trigger outputs shall be terminated at female BNC type panel jacks, located on the rear surface of the interrogator equipment units unless otherwise specified.

3.3.9.5.1 Beacon sync trigger outputs.- Five separate, isolated beacon sync trigger outputs shall be provided in each interrogator channel. These output triggers shall be identical in time with the beacon sync trigger (3.2.1). Three of these outputs from each interrogator channel shall be routed to and switched by the control and transfer equipment so that the selected operating channel trigger is available for remoting and synchronization of external equipment at the transmitter site. One of the unswitched outputs from each channel shall be for defruiter synchronization. The remaining output shall be reserved for future use.

3.3.9.5.2 Mode trigger outputs.- The following isolated mode trigger outputs, comprised of P1 and P3 pulses, shall be provided in each interrogator channel:

(a) Destaggered mode triggers for remoting - one each

(b) Destaggered mode triggers for synchronizing external equipment - two each

(c) Destaggered mode triggers for synchronizing defruiting equipment - one each

(d) Staggered mode triggers for future use - one each

The mode trigger outputs (a) and (b) above shall be routed to and switched by the control and transfer equipment so that the selected operating channel mode triggers are available on the rear surface of the CTU for remoting and connection to external equipment. Occurrence of the mode trigger outputs shall be at the same time of the corresponding interrogation pulses.

3.3.9.5.2.1 Non-sensitive mode trigger (P3) output.- Each interrogator channel shall provide a single, non-sensitive mode trigger output pulse occurring at P3 pulse time for every interrogation. This P3 trigger output pulse shall be destaggered and shall be routed to and switched by the control and transfer equipment. The P3 trigger output pulse shall be available at the rear surface of the CTU as a trigger source for the AN/GPA-124.

3.3.9.5.3 Mode designator trigger outputs.- Each interrogator channel shall provide the following mode designator trigger outputs:

(a) X - Mode Trigger
(b) Y - Mode Trigger
(c) Z - Mode Trigger

Each mode designator trigger shall consist of a single pulse occurring at P3 time of the appropriate interrogation period. These triggers shall be destaggered, and shall be mode sensitive. That is, the P3 output pulse shall appear at the output jack only when that particular mode is interrogated on that particular mode designator.

3.3.9.5.4 Test equipment trigger output requirements.- The following trigger outputs with characteristics as specified in 3.3.9.5 shall be provided, each on a separate, isolated output jack, on the front of the pulse mode generator unit in each interrogator channel for synchronization of test equipment:

(a) Beacon sync trigger (3.4.2.1.3)
(b) An individual trigger at P3 time, staggered, not mode sensitive

3.3.9.5.5 Trigger monitor jacks.- Trigger monitor jacks shall be located on the front of the pulse mode generator unit in each channel. A single electrically isolated jack in each channel, connected to a wave form selector switch (3.8.3), will fulfill this requirement. A short circuit on the output of this jack shall not derogate system performance. A monitor output shall be provided for each type of trigger output specified in paragraphs 3.3.9.5.2, 3.3.9.5.2.1, and 3.3.9.5.3.

3.3.9.6 Receiver video outputs.- Three separate and isolated video outputs, each meeting the requirements of 3.4.3.12 shall be available at BNC jacks in each interrogator channel on the rear surface of the receiver/transmitter unit. Each of these receiver outputs in each channel shall be routed to and switched by the control and transfer equipment so that video from the selected operating channel is available for remoting and driving external equipment. The video from each output shall be destaggered. Each of the three outputs specified shall be designed to drive a properly terminated 75 ohm coaxial cable.

3.3.9.6.1 Buffered detector video output.- In addition to the three video outputs specified in paragraph 3.3.9.6, a separate, isolated, buffered detector output with the characteristics specified in paragraph 3.4.3.12.1 shall be provided at a BNC jack in each interrogator channel on the rear surface of the receiver/transmitter unit. This output shall be staggered and shall be designed to drive a properly terminated 75 ohm coaxial line.

3.3.9.6.2 Video monitor jacks.- Monitor jacks shall be provided on the front panel of the receiver/transmitter unit for each type of video output specified in 3.3.9.6 and 3.3.9.6.1. A single, electrically isolated, monitor jack in each channel associated with a waveform selector switch (3.8.2) will fulfill this requirement. A short circuit on the output of this jack shall not derrogate system performance.

3.3.9.7 Alternate video routing for defruiter interface.- When a defruiter is added to each channel of the interrogator, the video output for remoting (3.3.9.6) from each channel shall be routed directly to the input of the defruiter. The defruiter output will be routed through the control and transfer equipment to the input of the remoting equipment, except as required in paragraph 3.3.9.8. Video output and input jacks in the interrogator shall be readily accessible and amenable to this routing of the video signals.

3.3.9.8 Alternate trigger and video routing for landline remoting.- When landline remoting is required, and the line drivers are used, a beacon sync trigger (3.3.9.5.1), mode triggers (3.3.9.5.2), and either the receiver video (3.3.9.6) or defruiter output video (3.3.9.7) will be routed from each interrogator channel to the input of the line driver. The output of the line driver shall then be routed through the control and transfer equipment to the input of the remoting cable. Adequate provisions shall be incorporated in the interrogator equipment to route these signals in a straight forward manner.

3.3.9.9 Interface with Radar Beacon Performance Monitor, Type FA-8133.- The interrogator equipment shall include all RF, video, Trigger, gating signals, control circuits, and associated interface connections required to interface with Radar Beacon Performance Monitor, Type 8133. These interfaces shall be those required to enable the RBPM to perform its monitoring functions with the interrogator channels connected in the dual channel configurations with the channels adjacent to each other, or when the channels are operated separately as single channel systems. Interface provisions shall be such that monitoring shall be performed correctly in the presence of radar systems PRF staggering (3.4.2.1.1) and beacon system PRF staggering and destaggering (3.4.2.7).

3.4 Performance requirements.-

3.4.1 Interrogation transmitter equipment characteristics.- The interrogation transmitter equipment shall incorporate the following characteristics:

(a)	Frequency	: 1030 $\pm$ 0.2 MHz
(b)	Max. peak power capacity	: Not less than 35 dBw
(c)	Nominal peak power (Adjusted)	: 35 DB above one watt with facilities for adjustment to any value between 35 dB and 17 dB above one watt as measured across a 50 ohm resistive load at the antenna output jacks of the equipment (3.3.9.1), using RF pulse P1 as the measured parameter.

(d) Relative Peak Pulse Power of P1, P2 and P3	:	The relative peak RF power of pulses P1 and P3, as measured at the directional antenna output jack, shall be equal within 1.0 dB. The peak RF power output of pulse P2 as measured at the omni-directional antenna output jack, shall be within 1.0 dB of the P1 peak RF power as previously measured.
(e) RF pulse duration	:	0.8 $\pm$ 0.1 microsecond
(f) RF rise time	:	Not greater than 0.1 microsecond nor less than 0.05 microsecond
(g) RF pulse top	:	Between points b and c defined in Figure 1, the amplitude of the pulses shall not differ by more than $\pm$ 1 dB from amplitude A.
(h) RF pulse decay time	:	Not greater than 0.2 microsecond, nor less than 0.05 microsecond.
(i) PRF (Triggered or free-running)	:	150 to 450 interrogations per second
(j) RF interrogation pulse (P1 - P3) spacing	:	3, 5, 8, 17, 21, and 25 $\pm$ 0.1 microseconds
(k) SLS pulse (P2) position	:	2 $\pm$ 0.1 microseconds after P1, adjustable as specified in 3.4.2.2

3.4.1.1 Transmitter characteristics for processing external modulation signals.- Where applicable the requirements of 3.4.1 shall apply. The transmitter shall generate RF interrogations in response to the external modulation signals (3.3.9.4.1). Pulse characteristics of these signals shall be maintained within their specified tolerances during RF transmission. The pulse train droop of the Mode 4 Challenge shall not exceed 1.0 dB when operated at maximum peak power (35 dBw) and over the entire range of service conditions (3.3.2).

3.4.1.2 Transmitter frequency control.- The transmitter shall be of the direct crystal controlled type. Automatic frequency control of the transmitter is not acceptable. The frequency shall remain constant at 1030 $\pm$ 0.2 MHz throughout the range of the service conditions.

3.4.1.2.1 RF tuning.- Transmitter tuning shall be accomplished by reference to a tuning meter or oscilloscope waveform or both. Adjustment of each tuning control shall produce only one indication of proper adjustment throughout the range of the tuning control. The meter or waveform connection required in tuning the transmitter shall not change the tuning of the transmitter circuits when connected or disconnected from the circuit subsequent to final tuning.

3.4.1.3 RF power output.- The transmitter shall be designed to deliver not less than 35 dBW peak power continuously at 1.0 percent duty cycle into a 50 ohm resistive load at the antenna jacks when operated in the Improved SLS configuration and with the attenuators (3.4.1.10) set for zero dB attenuation. Relative peak power of RF pulses shall be as specified in 3.4.1 and 3.4.1.1.

3.4.1.3.1 RF power output adjustments.- Maximum transmitter power output at 1.0 percent duty cycle shall be maintained within $\pm$ 1.0 dB for a minimum of 500 hours without resetting the transmitter power adjustments.

3.4.1.4 RF power range.- The nominal RF power output at the antenna jacks (3.4.1 and 3.4.1.1) shall be continuously adjustable from 35 dBW down to 17 dBW. The RF power output shall remain constant at any set value within 1.0 dB throughout the range of the service conditions.

3.4.1.5 RF pulse shape.- The RF pulse shape of all transmitted pulses shall meet the requirements of 3.4.1 and 3.4.1.1 at all power outputs between 35 dBW and 17 dBW. To meet the requirements of this paragraph, it shall be permissible to readjust transmitter tuning controls when power output adjustment is made.

3.4.1.6 VSWR.- The transmitter shall deliver the specified RF power output at the antenna jacks with all values of load impedance which present a standing wave ratio of up to 3.5 db (1.5 to 1 VSWR) at the antenna jacks, with the incident and reflected pulses coincident over at least 98% of their duration.

3.4.1.7 Transmitter delay and jitter.- The delay between the leading edge of a pulse delivered to the modulator and the leading edge of the RF envelope of the resulting transmitted pulse shall not be greater than 0.8 microsecond. The jitter in either of a pair of successive RF pulses shall not exceed 0.06 microsecond as referred to the radar pretrigger or self-trigger.

3.4.1.8 Transistor and tube change.- On replacing the transistors and tubes in the transmitter circuits in an equipment which was in normal operation prior to the replacement, the adjustments provided shall be sufficient to bring the circuit back into normal operation. It shall not be necessary to select transistors or tubes to meet this requirement. Circuit design shall assure a minimum of 1000 hours of transmitter tube life. End of tube life is defined as being the condition when transmitter power output cannot be adjusted to produce 32 dBw.

3.4.1.9 Side lobe suppression.- The equipment shall include provisions for two types of side lobe suppression (SLS): basic three pulse SLS (3.2.9) and Improved SLS (3.2.9.1). The interrogation pulse pair (P1 and P3) and the SLS control pulse (P2) shall be generated by the same transmitter; circuitry shall be provided to accept and process external interrogation signals with SLS (see paragraph 3.3.9.4). Crystal diode type switches shall be employed to accomplish switching of the transmitter pulses between the directional interrogation antenna and the omni-directional SLS antenna (see 3.4.1.9.2 and 3.4.1.9.3.1). It shall be possible to "strap out" or bypass the Improved SLS feature and operate with the basic three-pulse SLS in the event of component failure or if other considerations make this desirable. Upon failure of the RF switch or switches, the P2 pulse shall automatically cease to be generated.

Generation of the SLS RF pulse shall be manually controlled by a switch located behind the front panel of the pulse mode generator (3.4.2)or behind the front panel of the receiver transmitter unit. When in the "OFF" position, generation of the SLS RF pulse shall be inhibited. This switch when in the OFF position shall generate the zero volt signal discussed in 3.3.9.4.2.1 to prevent generation of the Mode 4 P5 pulse.

3.4.1.9.1 Mode 4 SLS pulse (P5).- The external Mode SLS pulse (see 3.3.9.4.1) shall be processed similar to basic SLS signal routing. Gating of the RF switch or switches for processing Mode 4 SLS pulse (P5) to the omni-directional antenna terminal shall be as specified in 3.3.9.4.2. The signal specified in 3.3.9.4.2.1 shall be provided to the AN/GPA-124 for purposes of generating or inhibiting the M4 P5 pulse depending on the RF switch (switches) status. Processing and transmitting the Mode 4 SLS pulse (P5) shall be accomplished without degradation of adjacent pulses in the Mode 4 Challenge.

3.4.1.9.2 SLS switch characteristics.- The switches used to accomplish the SLS RF pulse switching functions shall have the following characteristics:

a.	Operating frequency	: 1030 $\pm$ 5 MHz
b.	Peak RF power handling capacity	: 7.5 KW maximum 5.0 KW nominal
c.	Insertion loss (when switched to either of the two switched directions)	: 0.5 dB maximum
d.	VSWR (when switched to either of the two switched directions	: 1.2:1 maximum
e.	Isolation (ratio between full output power of one output port to the quiescent output measured at the other output port)	: 30.0 dB minimum
f.	Switching time (to either of the two switched directions)	: 200 nanoseconds maximum

The output pulses from the diode switches shall have the same characteristics for rise time, fall time, and pulse top variation as specified in paragraph 3.4.1 and 3.4.1.1. The switches shall be capable of switching overlapped P2 and P3 pulses on Mode 1 without damage to diodes or switches. The SLS switches and diode characteristics shall be such that the diodes can be changed in the field by maintenance personnel and any realignment that may be required can be performed in a straight forward manner without utilizing special tools or test equipment. The switches shall be mounted so as to be readily accessible, and shall not obstruct other transmitter components or adjustments.

3.4.1.9.3 Basic SLS signal routing.- When operating in the basic three-pulse SLS configuration (3.2.9), the P1 pulse from the transmitter shall be routed to the directional antenna output jack (3.3.9.1). The SLS switch shall then change states in time to route P2 to the omni antenna output jack (3.3.9.1). Prior to the start of P3, the SLS switch shall revert to its original state in order to route P3 to the directional antenna output jack. With the attenuators specified in paragraph 3.4.1.10 set for zero attenuation, the P1-P3 pulse power level at the directional antenna jack shall be within 1 dB of the P2 pulse power level at the omni-antenna jack.

3.4.1.9.4 Improved SLS requirements.- Additional SLS switching circuitry, power dividing circuitry, load isolating circuitry and gating circuitry (3.4.2.6.1) shall be used for Improved SLS. The switching, power dividing and load isolating circuitry may be either an integrated microwave unit or separate switches, power dividers, and load isolators interconnected by cables of non-critical lengths. The Improved SLS circuitry shall be designed such that revision to basic three-pulse SLS operation (3.4.1.9.2) can be easily accomplished.

3.4.1.9.4.1 Improved SLS signal routing.- When the transmitter is operated in the Improved SLS configuration, the RF power output (P1, P2 and P3) shall be divided and routed to both the directional and omni-directional signal paths. Through the use of the SLS switching circuitry and load isolating circuitry, properly gated, a portion of the P1 pulse power and the P2 pulse power shall be routed to the omni-directional antenna output jack. The P1 power level at the omni-directional antenna output jack shall be 3 dB $\pm$ 1 dB less than the P2 power level measured at the same point. The remaining portion of the P1 power and the P3 power shall be routed to the directional antenna output jack. With the attenuator (3.4.1.10) set for zero dB attenuation, the P1 power level at the directional antenna output jack shall be equal to the P2 power level at the omni-directional antenna jack (as previously measured) $\pm$ 1 dB and the P3 power level at the directional antenna output jack shall be equal $\pm$ 1 dB to the P1 power level measured at the same point.

3.4.1.10 Directional signal attenuator.- An attenuator, variable from 0 to 6 dB either continuously or in steps no greater than 1 dB, shall be installed in the directional antenna signal path for adjusting the ratio between directional antenna and omni-antenna input power. This attenuator shall be installed at a point where received signals are not affected by it and at a point where its effects will be seen by the power monitor. The maximum peak power requirements specified in 3.4.1 and 3.4.1.1 shall be met with this attenuator set for zero dB attenuation. With the attenuator set for 6 dB attenuation in the directional transmit signal path, the relative power levels of RF pulses at the antenna output jacks shall be as follows:

a. Directional antenna output jack	:	(1) P3 equal to P1 within $\pm$ 1 dB. (2) Pulse train droop for Mode 4 Challange shall apply (3.4.1.1)
b. Omni-directional antenna output jack	:	(1) P2 6 dB $\pm$ 1 dB greater than the P1 pulse at the directional antenna output jack. (2) P1 3 dB $\pm$ 1 dB less than the P2 pulse.

3.4.1.11 Spurious and CW radiation.- CW and other spurious RF signals delivered by the transmitter into a 50 ohm resistive load terminating the antenna output jacks of the equipment shall not be stronger than 46 dB below one milliwatt.

3.4.1.12 Interchannel interference.- There shall be no detectable interference between channels which would derogate the performance of the radiating channel or interfere with the normal maintenance and adjustment of the non-radiating channel. Modulators and RF units shall be provided with shielding designed to minimize interference. Radio interference (radiated and conducted) tests shall be conducted in accordance with Classes A and B of MIL-STD-461 and shall conform to the limits of that standard.

3.4.1.13 Susceptability to high power radar interference.- The interrogator is required to operate in the close proximity of high power S and L band primary radar equipment. Percautions shall be taken in the design, shielding etc., of the interrogator equipment to minimize interference from these sources.

3.4.2 Pulse mode generator.- The pulse mode generator shall accept trigger pulses from the associated primary radar and provide countdown of these triggers, or generate its own internal trigger as selected by a trigger selector switch (3.4.2.1). The beacon sync trigger from one of the preceding two sources shall be delayed as required and processed to deliver such pulses as specified in 3.4.2.2 and 3.4.2.3. The radar trigger shall also be available (3.3.9.3) for use in both the selected and non-selected channels of the interrogator. The pulse mode generator shall also include PRF staggering and destaggering, mode interlace, and both normal and Improved SLS gating circuitry.

3.4.2.1 Trigger processing.- A trigger selection switch shall be provided in the pulse mode generator which will allow the selection and processing as the beacon sync trigger of either of two trigger sources as specified in the following paragraphs:

3.4.2.1.1 Associated operation.- When the trigger selector switch is set to the associated position, the pulse mode generator shall accept trigger pulses from the associated primary radar system. These radar input trigger pulses will have the following characteristics:

(a)	Polarity:	Positive
(b)	Duration:	0.3 to 2.5 microseconds
(c)	Amplitude:	5 to 50 volts peak across 75 ohms input terminating resistor
(d)	PRF:	Any rate from 150 to 1500 pulses per second inclusive
(e)	Rise time:	Not more than 20% of pulse duration

When the radar triggers occur at a rate below 300 pulses per second, beacon sync triggers coincident with and at an identical rate to the radar triggers, shall be passed by the countdown circuit. When radar triggers occur at a rate between 300 and 1500 pulses per second, the sync triggers shall occur coincident with and at a rate which is equal to or an integral sub-multiple of the radar triggers but at a rate not to exceed 450 pulses per second. An adjustable control shall be provided in the countdown circuit for countdown ratio adjustment. A monitor jack shall be provided on the front panel of the pulse mode generator and connected so that the input trigger and counted down trigger can be viewed simultaneously on an external synchroscope to permit rapid determination of the countdown ratio. When adjusted for proper countdown with radar triggers of any PRF within the range of (d) above, this countdown rate shall be maintained without readjustment over the service conditions.

When the beacon interrogator system is associated with a primary radar that employs a 6 step stagger pattern with up to $\pm$ 30% PRF variation, the radar triggers will be counted down by the radar and fed to the beacon system at the counted down rate (150 to 450 pps), and at the stagger rate of the radar. The pulse mode generator shall accept these staggered and counted down triggers and shall generate the beacon sync trigger at a corresponding rate and stagger rate without countdown.

3.4.2.1.2 Self-trigger operation.- When the trigger selector switch is set to "Self-trigger," the radar triggers shall be automatically disconnected, and the pulse mode generator shall generate internally the beacon sync triggers required for otherwise normal operation. When the self-trigger is selected, the repetition rate of the beacon sync trigger shall be adjustable over the range of 150 to 450 trains per second by a separate, easily accessible control.

3.4.2.1.3 Beacon sync trigger distribution.- The beacon sync trigger as selected by the trigger selector switch (3.4.2.1) shall be available at a BNC connector on the front of the pulse mode generator for synchronizing test equipment (3.3.9.5.4). The beacon sync trigger shall be available in the pulse mode generator for supplying a trigger to the trigger time monitor (3.4.4.2) when independent self-triggered operation is selected.

3.4.2.1.4 Trigger delay.- A delay circuit shall be provided, subsequent to the output of the countdown (3.4.2.1.1), self-trigger (3.4.2.1.2) and distribution (3.4.2.1.3) circuitry, to adjust the delay between the beacon sync trigger and the mode pulse (P3) of the transmitter output. The delay shall be capable of being manually set to any value between 40 microseconds and 150 microseconds. Once this delay has been established, the delay shall remain constant regardless of the interrogation mode(s) being transmitted. The set delay shall be sufficiently stable so that the combination of its drift and the trigger time monitor drift shall not result in an alarm throughout the range of the service conditions. The output of the delay circuitry shall provide triggers to the mode encoding circuits at a rate identical to that of the input pulses to this circuit.

3.4.2.2 Modes of interrogation.- When a sync trigger pulse is passed by the trigger delay circuit, any one of the modes specified in 3.4.2.3 consisting of RF pulse pairs delayed as stated in 3.4.2.1.4 shall be generated as selected by the mode control circuits. In addition to the P1-P3 interrogation pulse pair, an SLS control pulse, P2, shall be generated. Adjustment shall be provided for positioning P2 2 ± 0.1 microseconds following P1. The position of P2 with respect to P1 shall remain constant for any mode or mode interlace ratio selected.

3.4.2.3 Interrogator mode generation.- The pulse mode generator shall be capable of generating interrogation modes with pulse spacing up to a maximum of 25 microseconds. To meet this requirement, circuitry shall be provided that will, when selected and connected to pulse mode generator circuitry, produce RF output pulses at 3 ± 0.1, 5 ± 0.1, 8 ± 0.1, $17 + 0.1$, 21 ± 0.1, or 25 ± 0.1 microseconds preceding the last transmitted pulse (P3).

3.4.2.4 Mode selection.- The control unit of each interrogator channel shall provide mode selection capability by means of individual switches. The mode switches shall enable mode designators X, Y, Z (3.4.2.5) to be any one of the Modes 1, 2, 3/A, B, C, and D (see 3.2.3 and the U. S. National Standard). Remote control shall be provided for the selection of any one of the mode designators X, Y, or Z and for selection of Modes 1, 2, 3/A, B, C, or D on the selected mode designator. When activated, the remote control circuitry shall override the local control circuitry such that Mode 1, 2, 3/A, B, C, or D can be substituted on the selected mode designator for the mode pre-set on the control unit. When the remote control is not activated at the remote control box or when remote control is not connected, the control unit shall have full operational control of modes, mode designators, and interlace pattern. Not more than five remote control wires or link channels shall be required for full operation of the

above remote control functions.

3.4.2.5 Mode interlace.- The mode interlace circuitry shall provide for selected interlace of three interrogation modes, two interrogation modes, or operation on a single interrogation mode (no interlace) at full beacon sync trigger PRF. The following specific interlace patterns shall be attainable for three mode designators (X, Y, Z) by operation of a switch on the control unit:

(a) No interlace - continuous interrogation on X
(b) No interlace - continuous interrogation on Y
(c) No interlace - continuous interrogation on Z
(d) X, Y, X, Y, X, Y, etc.
(e) X, X, Y, X, X, Y, X, X, Y, etc.
(f) X, Y, Z, X, Y, Z, X, Y, Z, etc.
(g) X, Y, X, Z, X, Y, X, Z, etc.

If the system is operating on a staggered PRF, the staggering sequence shall automatically change to meet the requirements of paragraph 3.4.2.7 when any of the above interlace patterns are selected.

3.4.2.6 Side lobe suppression (SLS) switch gating.- The pulse mode generator shall provide the circuitry necessary to gate the diode switch used to accomplish basic three pulse SLS as specified in paragraphs 3.4.1.9.1 and 3.4.1.9.3. The circuit design shall be such that the SLS trigger to the transmitter modulation is inhibited when the gating pulse to the SLS diode switch fails to be generated. The shape, duration, and position of the gating signal shall be such as to provide performance meeting the requirements of this specification when the equipment is operated in any of the modes (3.4.2.4) and mode interlace patterns (3.4.2.5). This gating signal shall be fed to a connector on the SLS switch.

3.4.2.6.1 Additional gating for Improved SLS switch.- Circuitry shall be incorporated in the pulse mode generator to furnish an additional gating signal to enable the Improved SLS switch to provide the switching function described in paragraphs 3.4.1.9.1 and 3.4.1.9.4.1. The shape and duration of the additional gating signal shall be the same as specified for the three-pulse SLS switch gate (3.4.2.6). The additional gating signal shall meet the position and duration requirements when the interrogator is operated in any of the modes (3.4.2.4) and mode interlace patterns specified in paragraph 3.4.2.5. The additional gating signal shall be fed to a separate connector on the Improved SLS switch.

3.4.2.7 PRF staggering and destaggering.- PRF staggering and trigger and video destaggering circuitry shall be incorporated in the pulse mode generator. The purpose of this staggering/destaggering circuitry is to provide for cancellation of second-time-around targets (3.2.8) from the display when the interrogator is used with either a defruiter or the common digitizer, type AN-FYQ-47. Second-time-around targets shall be made to appear jittered in the destaggered beacon video with reference to the non-staggered

beacon sync trigger. The stagger times, with respect to the beacon sync trigger, shall be -3.6 ± 0.025 and + 3.6 ± 0.025 microseconds with a total stagger time delay of 7.2 ± 0.05 microseconds. The staggering sequence, or pattern, shall be chosen such that the second-time-around targets shall be approximately evenly distributed in five range bins of the common digitizer. Elimination of the second-time-around targets will occur in the digitizer when the target count in a particular range bin is less than the number of hits required to declare a target. The common digitizer threshold, for declaring a target, can be set anywhere from one to eleven hits out of eleven. The nominal threshold setting is expected to be five out of eleven hits. The elimination of the second-time-around targets will occur in the defruiter when two consecutive returns on the same mode are displaced in time. The PRF staggering sequence shall be chosen, or automatically adjusted in response to changes in the interlace pattern, so that the above described distribution or anti-coincidence is achieved for all combinations of interlace patterns specified in paragraph 3.4.2.5.

3.4.2.7.1.- Video and trigger destaggering circuitry shall provide an essentially linear voltage transfer function over a range of zero to four volts input amplitude. In response to a PRF stagger gate the appropriate ± 3.6 ± 0.025 microsecond delay shall be inserted or bypassed for the purpose of realigning the applied reply code video to the basic system timing. PRF staggering and destaggering features shall be selectable by operation of a single switch located on the pulse mode generator. Use of these features shall not derogate the overall system performance.

3.4.3. Receiver characteristics.- The receiver shall be a superheterodyne type. The local oscillator frequency shall be below the carrier frequency of the signal to be received. The receiver shall connect to the common directional interrogation antenna through a diplexer. The diplexer shall provide sufficient isolation to adequately protect the receiver from any adverse affects of the transmitted signal. The receiver shall perform and shall contain the features as specified in the subparagraphs below:

3.4.3.1 Receiver frequency.- The receiver center frequency shall be 1090 MHz.

3.4.3.1.1 Frequency drift and bandwidth decrease.- The total frequency drift shall not exceed ± 0.2 MHz and the overall bandwidth of the receiver shall not decrease by more than one megaHertz over the service conditions.

3.4.3.2 Local oscillator.- The local oscillator shall be of the direct, crystal controlled type. An automatic frequency control of the local oscillator is not acceptable. The local oscillator frequency shall differ from the receiver center frequency by 60 ± 0.2 MHz at 25°C. Since the local oscillator and transmitter frequencies are the same, the contractor should consider use of a single crystal controlled oscillator and frequency multiplier chain for both transmitter and local oscillator.

3.4.3.2.1 Local oscillator shielding.- The signal delivered by the local oscillator into a 50-ohm resistive load terminating the directional antenna output jack of the receiver-transmitter equipment, shall not be stronger than 46 dB below one milliwatt.

3.4.3.2.2 Local oscillator test jack.- An internal test jack shall be provided for checking the local oscillator frequency and power. The output shall be sufficiently decoupled so that test equipment will not affect the oscillator's output.

3.4.3.3 Receiver sensitivity and noise figure.- The tangential receiver sensitivity* shall not be less than 87 dB below one milliwatt as measured at the fixed injection directional coupler. The tangential signal is the signal that raises the observed noise amplitude by its own amplitude as seen on an A-scope. The overall noise figure of the receiver shall not exceed 9 dB. The tangential receiver sensitivity as specified herein shall be the normal receiver sensitivity.

*See MIT Radiation Laboratory Series Vol. II, P. 228.

3.4.3.3.1 Sensitivity drift.- The sensitivity of the receiver at the center frequency of the pass band shall not be reduced by more than 5% and the gain of the receiver shall not vary by more than 5% from the specified magnitudes over the service conditions.

3.4.3.4 Overall bandwidth.- The overall receiver bandwidth as measured at the second detector shall be equal to or greater than 8.0 MHz between points 3 dB down and less than 18 MHz between points 40 dB down from the maximum response. No point on the selectivity curve between $\pm$ 3 MHz from the center frequency shall differ in amplitude by more than 1 dB from any other point. If two or more peaks occur between the points 3 dB down from the maximum response, the dip between any two peaks shall be no greater than 0.5 dB below the level of the lower peak. These characteristics shall be maintained over the full range of the manual gain control. The width specified above shall not decrease by more than 5% over the service condition.

3.4.3.5 Intermediate frequency.- The mid-frequency between points 6 dB down from the maximum response of the IF amplifier shall be 60.0 $\pm$ 0.5 MHz.

3.4.3.5.1 Image response.- The image response of the receiver shall be down 90 dB or more referred to the normal sensitivity (3.4.3.3) at the receiver frequency.

3.4.3.6 Manual IF gain control.- A manual IF gain control (screw driver adjusted) shall be provided on the front panel of the receiver unit. The receiver gain, expressed as a function of the angle of rotation of the control, shall increase approximately logarithmically over a range of at least 30 dB in the presence of STC (3.4.3.7) or 55 dB in the absence of STC, as the control is rotated clockwise. The control of gain shall be effective

over at least 200° rotation of the control. The sum of attenuation produced by the manual IF gain control and the STC circuit need not exceed 80 dB. Provision for locking the gain control in any preset position shall be provided. The gain control circuitry shall be designed such that with the gain adjusted for 1/2 volt noise output at the buffered detector output (3.4.3.12.1), which is the normal IF gain, overloading by the incoming RF or IF signal shall not take place in any portion of the receiver preceding the video amplifier of the receiver for RF input levels up to 23 dB below one milliwatt. No humps or video ringing shall be produced at the buffer detector output (or the input of the quantizer) and no extraneous pulses shall be produced at the quantizer output for incoming RF signals up to -23 dBM. The gain control circuit shall include filtering to prevent AC and RF signals from being impressed on the IF signal.

3.4.3.7 Receiver sensitivity time control (STC).- The receiver gain shall, in the quiescent state, be down 7 dB or more referred to the normal sensitivity. Between zero and the range time corresponding to approximately one mile (i.e., 15.36 microseconds including transponder delay) after the last interrogation pulse is transmitted, the gain shall rise to a value adjustable between 10 and 50 dB below the normal sensitivity (3.4.3.3). From this point, the gain shall continue to rise toward normal sensitivity at a rate of 6 dB each time the range is doubled. Maximum deviation from this specified gain versus time curve shall not exceed $\pm$ 1.5 dB at any point. The gain shall, after reaching normal sensitivity, remain at this value for the duration of the STC gate, and then return to the quiescent value. Adjustment of the STC circuitry shall be by means of one or more internal, locking, screwdriver adjust controls.

3.4.3.7.1 Gate only - no STC action.- An internal switch shall be provided which when in the OFF position will make the sensitivity of the receiver independent of the STC circuitry but still under the control of the manual IF gain control. In this condition, the receiver sensitivity when internally or externally triggered shall rise from the 75 dB below normal sensitivity to within 3 dB of normal sensitivity within 25 microseconds.

3.4.3.7.2 Receiver-STC gate length.- After the receiver reaches its normal sensitivity, the gain shall remain within 1 dB of its normal value for a time interval of continuously adjustable length such that the total duration from the last transmitted pulse shall be adjustable over the range from 300 to 2500 microseconds. Where the PRF exceeds 350 interrogations per second, the gate maximum length shall be at least 90% of the pulse period. It shall be possible to preset the length of the gate by means of a locking type, screwdriver adjust potentiometer located behind the front panel of the receiver/transmitter unit. Jitter on the trailing edge of the gate shall not exceed 0.1 percent of the gate duration.

3.4.3.7.3 Receiver-STC gate recovery.- At the end of the gate time, the gain of the receiver shall fall to at least 75 dB below its normal sensitivity as rapidly as practicable, but within 50 microseconds.

3.4.3.8 Interference rejection.- The receiver shall be capable of operating through CW interference as follows:

3.4.3.8.1.- A pulse signal of 84 dB below one milliwatt shall be preceptible through CW interference of 66 dB below one milliwatt. Signals greater than -84 dBm (for example -76 dBm) shall be perceptible through CW interference of -66 dBm. Signals of -84 dBm and signals greater than -84 dBm (for example -76 dBm) shall be perceptible through CW interference of lower than -66 dBm (for example CW interference of -75 dBm).

3.4.3.8.2.- With the gain control set to give 0.5 volt of noise as observed at the receiver buffer detector output (3.4.3.12.1) on an "A" scope in the absence of CW, a CW signal 66 dB below one milliwatt or stronger having 30% modulation at 1000 Hz shall produce not more than one volt peak to peak at the receiver output (3.4.3.12), corresponding to the 1000 Hz modulation envelope and its harmonics.

3.4.3.8.3.- The interference rejection circuits used shall not impair the normal pulsed operation of the receiver in the absence of interference.

3.4.3.9 External intermediate-frequency signal rejection.- Sensitivity of the receiver to energy in the IF frequency band, either stray or impressed at the antenna terminal, shall be down 60 dB or more referenced to the specified sensitivity at the tuned frequency of the receiver.

3.4.3.10 Fidelity and recovery characteristics.-

3.4.3.10.1.- A signal as described in 3.4.3.10.1.1 impressed at the input of the receiver, with the gain control set to give average peak noise output voltage of 1/2 volt 30 microseconds after the STC circuit has allowed the receiver gain to reach normal IF gain level (3.4.3.6) as observed on an "A" scope connected to the buffered detector output (3.4.3.12.1) shall produce a signal as described in 3.4.3.10.1.2 across 75 ohms with the output of the receiver (3.4.3.12) adjusted to 2 volts, at any time from 15 to 2500 microseconds after the second interrogation pulse.

3.4.3.10.1.1 Input signal.-

(a)	Duration:	0.35 ± 0.01 microsecond
(b)	Amplitude:	A signal 24 dB above the receiver sensitivity at each point of measurement
(c)	Rise time:	Not greater than 0.1 microsecond
(d)	Decay time:	Not greater than 0.15 microsecond
(e)	Slope:	Not greater than 2%

3.4.3.10.1.2 Output signal.-

(a)	Duration:	0.35 to 0.4 microsecond
(b)	Amplitude:	Quantized to full output, adjusted to 2 volts
(c)	Rise time:	Not greater than 0.1 microsecond
(d)	Decay time:	Not greater than 0.2 microsecond
(e)	Slope:	Not greater than 2%

3.4.3.10.2- RF input pulse train No. 2 as described in 3.4.3.10.2.2 shall be impressed at the receiver input in such a manner that the leading edge of the first pulse of the train occurs 0.7 microsecond after the leading edge of any pulse of RF input pulse train No. 1 described in 3.4.3.10.2.1 and impressed at the receiver input. The resultant signals produced across a 75 ohm terminating resistor at the receiver output with the receiver gain set as specified in 3.4.3.10.1 shall be as described in 3.4.3.10.2.3.

3.4.3.10.2.1 Input pulse train No. 1.-

(a)	Number of pulses:	15
(b)	Spacing of pulses:	First and last pulse spaced 20.3 $\pm$ 0.1 microseconds leading edge to leading edge; other pulses equally spaced in increments of 1.45 $\pm$ 0.05 microseconds from leading edge of first pulse
(c)	Amplitude:	20 dB above the input signal level required to produce an output signal of one volt at the buffer detector.
(d)	Duration of pulses:	0.55 microsecond
(e)	Rise time of pulses:	0.1 microsecond maximum
(f)	Decay time of pulses:	0.2 microsecond maximum
(g)	Droop of pulse train:	Not greater than 2%

3.4.3.10.2.2 Input pulse train No. 2.-

(a)	Number of pulses in train	: 15

(b)	Spacing of pulses:	First and last pulse spaced 20.3 ± 0.1 microseconds leading edge to leading edge; other pulses equally spaced in increments of 1.45 ± 0.05 microseconds from leading edge of first pulse
(c)	Duration of pulses:	0.55 microsecond
(d)	Amplitude:	As required to produce a one-volt signal at buffered detector output (3.4.3.12.1) of receiver in absence of input pulse train No. 1
(e)	Rise time of pulses:	0.1 microsecond
(f)	Decay time of pulses:	0.2 microsecond
(g)	Droop of pulse train:	Not greater than 2%

3.4.3.10.2.3 Output pulse train produced by input pulse train No. 2 and No. 1.-

(a)	Number of pulses in train:	15
(b)	Spacing of pulses:	First and last pulse spaced 20.3 ± 0.1 microseconds leading edge to leading edge; other pulses equally spaced in increments 1.45 ± 0.05 microseconds from leading edge of first pulse
(c)	Duration of pulses:	0.60 microseconds maximum
(d)	Amplitude of pulses:	Quantized to full output and adjusted to 2 volts
(e)	Droop of pulse train:	Not greater than 2%

3.4.3.11 Receiver delay.- The delay between the leading edge of the envelope of an RF pulse (pulse shall be approximately 63 dB below one milliwatt with a rise time of 0.1 microsecond or less with received gain set as in 3.4.3.10.1) and the leading edge of the video output pulse (derived at the video output of the receiver, 3.4.3.12) when the RF pulse is impressed at the antenna terminal shall not be greater than 0.5 micorsecond.

3.4.3.12 Video output (Quantized).- The video output circuitry of the receiver shall employ pulse width discrimination and pulse amplitude quantizing techniques. Received pulses of up to 0.20 microsecond duration shall be rejected, and received pulses of 0.30 microsecond duration or greater shall be accepted for quantizing. The duration of the quantized output pulses shall be not less than the duration of the incoming RF pulse and not greater than the incoming RF pulse duration plus 0.05 microseconds. Rise time of

the quantized pulses shall be between 0.05 and 0.1 microsecond and fall time of the quantized pulses shall be between 0.05 and 0.2 microsecond. The quantizing circuitry shall automatically determine the 6 dB (1/2 voltage) pulse width of each received pulse meeting the acceptance criteria, regardless of the pulse amplitude. An amplitude threshold level shall be provided to function automatically and with essentially optimum performance over the entire reply video range (video reply range is defined as all signals from tangential sensitivity up to -23 dBm). The threshold circuit shall automatically adjust to the average peak noise level of the receiver such that not more than 30 pulses per second as averaged over an interval of 30 seconds are present at the quantized receiver output when no signals are applied to the receiver input, and the receiver is adjusted for input signals equal to tangential sensitivity. Optimum performance shall be considered achieved when the number of quantized output pulses from the receiver equal the number of RF input signals to the receiver, and the quantized noise does not exceed the limits specified. The thresholding shall be based on receiver noise and not incoming fruit density. All reply video pulses that meet the pulse width acceptance criteria and fall within the above amplitude range shall be quantized to an amplitude of not less than 4.0 volts. The video level at each of the three outputs specified in paragraph 3.3.9.6 shall be continuously adjustable between 1 and 4 volts (nominal operating level is 2.0 volts). No humps, video ringing, baseline modulations, parasitic oscillations, or other instabilities shall be present on the video outputs with any position of gain and maintenance alignment controls.

3.4.3.12.1 Buffered detector output.- The characteristics of the buffered detector output (3.3.9.6.1) shall be essentially linear up to an output level of 2.0 volts. The output level shall be adjustable from 0.5 to 2.5 volts by means of an output control. An average peak noise amplitude level of 0.5 volts shall be obtainable for normal settings of the IF gain control.

3.4.4 Interrogator monitor (option).- When required by the contract schedule, two identical interrogator monitor units (channel 1 and channel 2) shall be provided. By means of appropriate connections, the monitor units shall monitor the RF power output and trigger timing of the respective channels. Each monitor shall receive its RF inputs from probes in the transmission line on the transmitter side of the antenna transfer switches (3.4.5.2). The RF pulse power to the directional antenna output jack as well as the RF pulse power to the omni-directional antenna output jack, shall be continuously monitored in each channel. Three separate lamps shall be provided on the front panel of each monitor to indicate a detected error in the directional power, the omni-directional power, and trigger timing. When an error is detected in the directional power, the local lamp shall remain in the failed condition until reset by a manual reset control on the monitor panel; the remote alarm, however, shall be cleared immediately upon correction of the error producing condition. This feature shall not be activated during channel changes or initial stabilization time following application of power.

3.4.4.1 Power monitor.- The power monitor shall be adjustable to any power level within the range of the transmitter (3.4.1 to 3.4.1.3) and shall employ calibrated sensitivity controls to adjust the monitoring levels to the established transmitter output. These controls shall have indicator dials and shall be sufficiently vernier to allow the monitor circuits to be accurately set to bracket the monitored parameters without ambiguities. The interrogate indicator lights on the front panel of the monitor unit (3.4.4) shall be lighted when the transmitted power level is within 0.7 dB of the adjusted monitor level, and a ground shall be applied to the interrogate readback control line (3.7.5) to activate the interrogate light at the indicator site. The interrogate lamps at the transmitter site shall be extinquished when the transmitted power deviates $\pm$ 1.0 dB from the adjusted monitor level and a separate ground shall be initiated for remoting to the indicator site. This ground shall cause the interrogate light on the control box to flash on and off to indicate an interrogate power error (3.7.6.4.3). In addition, this ground shall be available at the control transfer unit for use by external equipments. An error shall be indicated if the power level of P1 or P3 on the directional antenna transmission line, deviates beyond the $\pm$ 1.0 dB tolerance. Test points shall be provided as appropriate for adjustment and maintenance of the monitor. Stability of the power monitor shall be such that the error indications are not falsely activated over the service conditions.

3.4.4.2 Trigger time monitor.- In performing its function, the trigger time monitor shall disregard the first interrogation pulse (P1) and delay the second interrogation pulse (P3) until it is coincident with the primary radar zero range pulse (3.3.9.3). The delay in the circuit used to establish this coincidence shall be continuously adjustable between the values of 3 and 150 microseconds (minimum acceptable range). The monitor shall function properly when either non-staggered or staggered PRF (3.4.2.7) is used and shall not give erroneous indications under these conditions. When the delayed second interrogation pulse deviates more than $\pm$ 1 microsecond from the primary radar zero range pulse, a range error lamp and an audible alarm shall be energized on the front panel of the monitor unit and a ground shall be initiated for remoting to the indicator site. The primary radar zero range pulse shall be as specified in 3.4.2.1.1. A BNC type connector shall be provided on the rear surface of the monitor unit for connecting the radar zero range pulse (also see 3.3.9.3). Suitable waveform test points shall be provided for adjustment of the monitor. For beacon operation on self-trigger, it shall be possible, by the operation of a switch on the monitor chassis, to place the delay circuit in the monitor radar zero range pulse circuit, and connect the beacon sync trigger to the monitor radar zero range pulse input. It shall be possible to delay the beacon sync trigger until it is coincident with the beacon second interrogation pulse, P3. This shall allow the monitor to check the pretrigger time when the system is operated independent of a primary radar. The stability of the monitoring circuit shall be such, when properly adjusted, that the range error alarm is not falsely activated over the service conditions.

3.4.5 Control and transfer equipment.- The control and transfer equipment furnished with each interrogator channel shall include an antenna transfer unit, control unit, and control circuit d.c. power supply. These units shall provide all controls required in each channel for operation of the channel as an independent single channel interrogator remoted over landline or via microwave link. Two control transfer units (main and spare), each containing its own control circuit d.c. power supply, shall also be furnished with each dual channel interrogator system. One control transfer unit shall be installed in each channel rack, but sufficient space and blank panels shall be provided in each rack for mounting both control transfer units in one rack one above or below the other in a convenient operation position. The control and transfer equipment units shall be designed to meet the requirements specified in the following subparagraphs and other related requirements of this specification. All relays used in the control and transfer equipment, except for main power contactors and antenna transfer relays, shall be hermetically sealed plug-in type. Design of all units shall be such that following a power failure, the status of all control functions shall return to the status prevailing prior to the power failure.

3.4.5.1 Spare control circuits.- At least 20% (minimum one of each type used) spare control circuits shall be provided in the control and transfer equipment units (not applicable to the antenna transfer unit). These spare control circuits shall be completely wired through switches, relays and connectors and where appropriate, shall be terminated on rack terminal boards.

3.4.5.2 Antenna transfer unit.- The antenna transfer unit provided in each channel of the interrogator group shall accept both the directional and omni-directional RF outputs of both interrogator channels and transfer either channel of these outputs to the antennas and terminate the other channel outputs in dummy loads. In dual channel operation, it shall be possible to use either antenna transfer unit as the active unit and the other as the spare. For single channel operation, the antenna transfer unit in each channel shall accept both the directional and omni-directional RF outputs from the associated channel and transfer these outputs to either of the appropriate antennas or dummy loads in response to appropriate switching action initiated either locally or remotely through the control unit. The antenna transfer unit shall be constructed such that it may be removed from the cabinet and wall mounted if necessary to equalize cable lengths between separate channels.

3.4.5.3 Control unit.- The control unit provided in each interrogator channel shall contain all wiring, relays, switches, and other components required to interface the interrogator channel with the remoting equipment or the control transfer unit. The control unit shall provide all local

controls required for operation of the channel as a single channel interrogator system, and shall provide for operation of the channel as part of a dual channel interrogator system through circuits of the control transfer unit. This unit may be either a separate unit or an integrated part of the pulse mode generator unit.

3.4.5.4 Control transfer unit.- The two control transfer units with associated power supplies shall be constructed on pull-out drawer assemblies with 19-inch relay rack panels. The control transfer units shall provide all local and remote interchannel switching circuitry required for control of the dual channel system in any configuration ranging from one where the channels are located adjacent to each other feeding a common antenna system to one where the channels are separated up to 1,000 feet and feeding separate antennas. It shall be possible, by installing both control transfer units in one channel rack, to establish either channel location as the central control point for the dual channel system. In addition, it shall be possible to remove both control transfer units from the interrogator racks and install them (in a GFE rack) at any intermediate point between the transmitter site(s) and the remote indicator site and establish central control of the dual channel system from that point. This latter arrangement shall accommodate cases where two single channel interrogators feed into one control point over separate remoting systems. The control transfer units shall contain all wiring, relays, switches, and other components required to interface both channels of the dual channel interrogator system with the remoting equipment and external equipment as specified herein. When the units are collocated in one rack, changeover from the active unit to the spare unit shall be accomplished by transferring cables, having quick disconnect connectors, between units. Changeover shall be accomplished without requiring removal of either unit from the cabinet.

3.4.5.5 Remote interface.- Interface with the remoting equipment, either landline or microwave link, shall be accomplished through the control unit in the case of single channel operation or through the control transfer unit for dual channel operation. The remote control circuitry shall provide control over 12,000 feet of #19 gauge plastic insulated telephone cable pairs. This will necessitate any steadily applied voltage being not more than 48 volts d.c.; 60 Hz a.c. voltage on the control lines applied directly or indirectly, is prohibited. The remotely controlled circuitry shall accept grounds for initiation of control functions and remote readback indications shall be grounds.

3.4.6 Video and trigger remoting.

3.4.6.1 General.- The interrogator equipment shall be designed for remoting of the beacon sync trigger output (3.3.9.5.1), destaggered mode triggers (3.3.9.5.2) and system video, comprised of either the receiver output (3.3.9.6) or the defruiter output (3.3.9.7), over a government-furnished microwave link or a government-furnished coaxial cable up to 12,000 feet in length. Line drivers and line compensating amplifiers shall

be furnished, as required by the contract schedule, for use with government-furnished coaxial cable.

3.4.6.2 Microwave link remoting.- The beacon sync trigger, destaggered mode triggers, and beacon system video shall each be available from the on-line channel of the interrogator on separate BNC type 75 ohm panel jacks for connection to the input of the microwave link. The microwave link is designed to accept triggers with the characteristics specified in paragraph 3.3.9.5 and video with the characteristics specified in paragraph 3.4.3.12. The output of the microwave link at the indicator site consists of the beacon sync trigger on one line, mode triggers on one line, and the video on one line.

3.4.6.3 Coaxial cable remoting.- The coaxial cable remoting equipment specified herein, comprised of line drivers and line compensating amplifiers shall, when operated with an RG-13/U coaxial cable 12,000 feet in length, provide a minimum overall bandwidth of 5 megaHertz. Signal levels and video characteristics transmitted over the cable shall be such that faithful reproduction of the triggers and beacon system video from the interrogator shall be achieved at the outputs of the line compensating amplifier at the indicator site when these outputs are terminated in 75 ohms. Video standarization may be employed, but requirements of system performance with interleaved pulse trains shall be met.

3.4.6.3.1 Line driver (option).- The line driver shall accept the beacon sync trigger, destaggered mode triggers, and beacon system video on individual BNC type 75 ohm input jacks and combine these inputs for driving an RG-13/U coaxial cable from a single output. The video and trigger signals transmitted over the coaxial cable shall be of positive polarity. The level of the video signals transmitted over the coaxial cable shall be such that the uncompensated signal at the remote end shall be at least 1 volt when 12,000 feet of cable is used. The trigger level on the cable shall be greater than the video level by a ratio of not less than 2 to 1. The output of the line driver shall be routed through the control and transfer equipment (3.3.9.8). The line drivers shall be individual units mounted on pull-out drawer assemblies with 19-inch relay rack panels and each shall contain its own power supply. A line driver shall be provided for each channel of the interrogator equipment when required by the contract schedule.

3.4.6.3.2 Line compensating amplifier (LCA) (option).- The line compensating amplifiers shall compensate for the attenuation and phase shift versus frequency for the video and trigger signals remoted over the coaxial line. Sufficiently graduated control shall be provided to allow compensation for any line length between 200 and 12,000 feet. In addition, it shall separate the triggers from the video and provide the following outputs:

(a) Video outputs - 2 each*
(b) Beacon sync - 1 each
(c) Mode triggers (P1 + P3) - 1 each
(d) Beacon sync and mode triggers combined - 1 each

* Each video output shall be isolated and each level shall be adjustable from 0.5 to 5.0 volts across a 75 ohm termination.

The line compensating amplifiers shall each be mounted on pull-out drawer assemblies with 19-inch relay rack panels and shall each contain their own power supply. Two line compensating amplifiers, one operating and one a spare, shall be furnished with each transmitter site equipment when required by the contract schedule. The spare LCA shall be designed for mounting above or below the operating unit and shall be furnished with rapid disconnect input and output cable connectors to facilitate changeover from the operating to spare unit.

3.5 Power supplies.

3.5.1 Regulation.- All power supplies except those specifically exempted shall be electronically regulated to maintain output voltage within $\pm$ 1% as the load is varied from 10% less than to 10% more than the normal load, and as the line voltage is varied between service conditions limits with primary power regulators (if used) in the circuit. The following supplies are exempt from this requirement:

(a) Transmitter high voltage (above 300V)
(b) Control circuit low voltage

3.5.2 Bias protection circuitry.- Provisions shall be made to automatically remove the voltage from circuits which would be damaged by the loss or reduction of bias voltage when the bias voltage falls below a safe operating value.

3.5.3 Ripple voltages.- Ripple voltages, referred to as the peak-to-peak value of simple or complex waveforms consisting of power line frequency components and harmonics thereof, and synchronous transients, shall not exceed 0.2 volt peak-to-peak for all electronically regulated power supplies not specifically limited by other sections in this specification. The following supplies are exempt from this requirement:

(a) Control circuit low voltage
(b) Transmitter high voltage

The ripple voltage of all power supplies shall be such that further reduction of the ripple voltage would not result in any significant improvement in stability of operation, circuit control adjustments or indicator presentation. No tests are required to verify the last requirement.

3.5.4 Metering.- Meters and associated switches for use in measuring power supply output voltages and currents shall be supplied and shall be located in the cabinet containing the circuit to be metered. The following are exceptions to this requirement:

(a) Current - control voltage power supply

(b) Where the contractor and the Government mutually agree that no metering is required.

If a meter cannot be used for multiple functions without external shunts or multipliers, such shunts or multipliers shall conform to the requirements of paragraph 1-3.16.6.8 of Specification FAA-G-2100/1.

3.5.5 Transmitter/modulator high voltage power supply.- Each high voltage power supply shall furnish the DC power required by its corresponding modulator and transmitter. Regulation shall be such that requirements of 3.4.1 and 3.4.1.1 are met over the range of the service conditions. Ripple voltages generated within the HV power supply shall not cause the instantaneous voltage amplitudes of the RF pulses to fluctuate more than $\pm$ 5% from an average amplitude.

3.5.5.1 Overload protection circuit.- Following an overload, the overload protection circuit shall remove voltage from those circuits which may be damaged from overload. After approximately two seconds, the circuit shall automatically reset to normal operation. If three overloads occur in a period of 8 seconds or less, the high voltage shall remain off until reset manually or as provided below. An overload indication (target or light) shall be provided on the front panel of the high voltage power supply. The high voltage shall be automatically reset when the channel in which the overload has occurred is again selected as the operating channel or when a reset button on the front panel of the high voltage power supply has been operated.

3.5.5.1.1 Electrical overload protection.- See 1-3.7 of FAA-G-2100/1.

3.5.6 Control circuit power supplies.- The control circuit power supplies shall be 24 volt d.c. supplies and shall employ silicon type rectifiers and shall be self-protecting such that a continuous short circuit beyond the transformer primary will not damage the unit. It shall be possible to select either the channel 1 or channel 2 supply as the main supply. Automatic switchover from the main to standby supply shall occur upon loss of control voltage within the main supply. Fuses or circuit breakers shall be installed in the DC output branch circuits such that a short circuit on a branch circuit will not disable the entire control circuit power supply. Alternate approaches upon which the contractor and Government mutually agree will be accepted. If the control voltage is used to operate electronic circuitry, additional regulation and filtering shall be employed as necessary.

3.5.6.1 Regulation.- The following are allowable variations in the output under the conditions listed:

	Condition	Variation
(a)	Normal test conditions - zero double normal* load current	5% of normal supply voltage
(b)	Service conditions, range of temperature, humidity, all other conditions normal	1 volt
(c)	Service conditions range of AC-line voltage, all other conditions normal	1 volt
(d)	Service conditions range of AC-line frequency, all other conditions normal	± 2.5V from output voltage at 60 Hz

* Normal load current is considered to be the maximum current drain when all installed loads are simultaneously energized.

3.5.7 Power supply indicators.- Each circuit protected by a fuse or circuit breaker shall have an indicator lamp which shall be illuminated when the fuse or circuit breaker is open. Neon indicator lamps shall be used where practicable. All indicator lamps shall be uniformly located with respect to their associated fuses or circuit breakers. Indicator lights associated with circuit breakers may be omitted if the breaker(s) will light the channel "No-Control" lights when tripped or if the state of the breaker(s), on or tripped, can be determined by observing the position of the breaker operating lever with the equipment access doors closed.

3.5.8 Primary power.- All performance requirements for the system shall be met without readjustments when primary power supply voltages vary, rapidly or slowly, between the limits specified in paragraph 3.3.2. There shall be no discernible variation in system performance during primary power line voltage changes.

3.5.8.1 Line supply surges.- Line supply surges resulting in a maximum of 150 volts route mean square (VRMS) for one cycle shall not cause permanent damage to the equipment.

3.5.8.2 Voltage regulators.- If the contractor elects to use line voltage regulators as a means of meeting system performance requirements under service conditions, he shall furnish at least one complete line voltage regulator for each interrogator channel. All performance requirements shall be met with the voltage regulators in place and subjected to the service conditions along with the other equipment. Line voltage and frequency variations apply to the input to the voltage regulators. If designed for use with line voltage regulators, the equipment shall be usable and component ratings shall not be exceeded if the equipment is operated continuously without line voltage regulators in place, over the

range of line voltage and frequency specified under the service conditions; however, it is not required to meet specific performance limits without the regulators.

3.6 Standby channel.- Dual channel interrogator systems comprised of two identical interrogator channels, each complete and capable of independent operation, shall be furnished. The interrogator system shall be capable of dual channel operation with the channels located adjacent to each other and using a common antenna system, or with the channels separated up to a maximum of 1000 feet using separate antenna systems. Each channel shall be connected through the control and transfer equipment and antenna transfer units such that either channel can be selected as the operating channel by means of a single switch. Channel selection shall be possible from the control transfer unit and from the remote indicator site, but only one location shall have control at any one time. Design of the control circuitry shall be such that it shall be impossible for more than one set of local control and channel transfer switches (if such are provided) to have control at any one time. The channel selected as the operating channel shall be connected to the antenna system, and its outputs shall be available at BNC jacks for connection to external equipment. The unselected channel shall be terminated in an RF dummy load (3.9) through the antenna transfer unit, and its video and trigger outputs shall be terminated as specified. Transmit high voltage shall be removed from each interrogator channel during the channel transfer action, and the channel transfer action shall not occur prior to removal of the transmit high voltage and discharge of high voltage storage devices (also see 1-3.5.5 of FAA-G-2100/1).

3.6.1 Spare equipment units.- A spare unit shall be provided for any unit which is necessarily common to both interrogator channels. Spare units shall be installed side-by-side, above, or below the corresponding operating units and changeover from main to spare shall be made by transferring cables having quick disconnect connectors, from one unit to the other without removing either unit from the cabinet.

3.7 Control functions.- The following functions shall be controllable:

	Function	Remote line requirements
(a)	Main power ON/OFF	Not remoted
(b)	Defruit ON/OFF	Not remoted
(c)	Local/remote enable	one line*
(d)	Interrogate ON/OFF	one line*
(e)	Select channel 1/or channel 2	two lines*
(f)	Select mode designator X, Y, or Z	two lines*
(g)	Select mode 1, 2, 3/A,B,C,D	three lines*
(h)	Common ground for all control functions	one line*

*A control line is defined as one wire of a cable pair (3.4.5.5).

The main power ON/OFF and defruit ON/OFF shall be controllable only from the front panel of each interrogator channel. The local/remote enable funotion shall be controllable only by application of a ground from the indicator site. Function (d) shall be controllable from either the local control panel of each interrogator or the indicator site, but not simultaneously. Only the transmitter site central control point or the indicator site shall have control over function (e) at any one time, but not simultaneously. Functions (f) and (g) shall be controlled in accordance with paragraphs 3.4.2.4 and 3.7.6.4.6. All controls shall be initiated by application of grounds to the control lines or RML.

3.7.1 Point of control.- The point of control for the functions specified in 3.7, except main power ON/OFF, defruit ON/OFF, and local/remote enable, shall be selectable by a local/remote switch on the control and transfer equipment. This switch shall simultaneously change the point of control of the specified control functions to either local or remote control, except as modified in paragraph 3.7.2. A local/remote enable circuit shall be incorporated which shall be controllable only from the remote indicator site. When the enable switch is held in the operated position at the indicator site, it shall enable the local/remote switch at the transmitter site central control point to change the point of control from the remote to the local condition. It shall be possible to return the point of control to the remote condition by operation of the local/remote switch at the transmitter site central control point even though the enable switch is not operated. Transfer to local control shall be possible only when the local/remote enable switch is held in the operated position. A lamp adjacent to the local/remote switch shall indicate when the enable switch is held in the operated position.

3.7.2 Maintenance control.- It shall be possible to fully energize and have full alignment control of the non-selected channel for maintenance purposes. Each channel shall have a "maintenance-operate" switch which shall function as described in the following subparagraphs:

3.7.2.1 Maintenance position.- When the maintenance operate switch of the non-selected channel is operated to the "maintenance" position, selective control shall be provided for energizing of main power, non-transmit operating voltages and transmit high voltages. Those voltage circuits which are energized when the channel is selected by the remote control box (3.7.6) but are not a part of the transmitter high voltage circuitry, shall be provided with switches or circuit breakers for maintenance purposes so they can be energized without energizing the transmitter. All controls and adjustments, including local controls for all remoted functions, shall be in the same cabinet as the units they serve, except that local control of the defruit function shall be on the front panel of the control unit, and shall be fully operative. When the selected channel is under remote control, the operation of its maintenance operate switch to the maintenance position shall have no effect upon the channel. It shall not be possible for an operator at the remote location to select a channel that is under maintenance control.

3.7.2.2 Operate position.- When the maintenance-operate switch is in the "operate" position and the local-remote switch is in the remote position, the local maintenance controls shall be inoperative and the channel shall be available for selection at the remote control box (3.7.6) only.

3.7.3 No control indication.- Indicator lamps at the transmitter site and on the remote control box shall show when remote control is not possible because of any one or combination of the following: any of the local/remote switches being in the local position, any of the "maintenance-operate" switches being in the maintenance position, any interlocks or local power supply switches being open and when a defruiter no-control ground is present. For this purpose, two fixtures containing 60W red lamps, one for each channel, shall be provided for installation in the transmitter building. These lamps shall be provided with labels designated "No Control Channel 1" and "No Control Channel 2". Terminals for providing voltage to illuminate these lamps shall be provided at an easily accessible terminal board in each associated interrogator channel.

3.7.4 Radar trigger selection.- The beacon pretrigger and radar zero range trigger from the on-line radar channel will be pre-selected by the radar switching circuits. The interrogator equipment shall accept these triggers at the BNC jacks specified in paragraph 3.3.9.3.

3.7.5 Readback functions.- An indication of the following functions shall be read back to the indicator site from the transmitter site by application of grounds to the control lines or RML:

	Function	Readback line requirement
(a)	No Control	one line*
(b)	Channel 1 selected	one line*
(c)	Channel 2 selected	one line*
(d)	Defruiter ON	one line*
(e)	Interrogator main power ON	one line*
(f)	Power monitor normal (interrogate light on)	one line*
(g)	Power monitor alarm (interrogate light flashing)	one line*
(h)	Range error	one line*
(i)	Mode designator X, Y, or Z selected	two lines*
(j)	Mode 1, 2, 3/A, B, C or D selected	three lines*
(k)	Common ground for all read-back functions	one line*

* A control line is defined as one wire of a cable pair (3.4.5.5).

3.7.6 Remote control box (option).- When required by the contract schedule, remote control boxes shall be furnished. Its controls indicators, and construction shall comply with the following subparagraphs. The remote control box shall require no external power source other than 120 V AC primary source. The AC line shall be protected by a circuit breaker or shall be fused using a low silhouette non-indicating type fuse holder

located on the control box so as not to interfere with operating controls. Two identical control boxes, a main and a spare, shall be provided.

3.7.6.1 Construction. The remote control box shall be designed for flush-mounting in a panel of the operating consoles. The front panel shall be eight inches wide and 12 inches high. The maximum depth of the unit behind the panel shall not exceed five inches. A rear dust cover shall be provided to protect the control box components. The height of this dust cover shall not exceed 10 1/4 inches. The rear cover of the unit and controls mounted on the panel shall be arranged so that a 7/8-inch lip on the 8-inch dimension and 3/8-inch lip on the 12-inch dimension are left clear for mounting purposes. Two holes shall be drilled and countersunk in each 8-inch lip with centers spaced 7 inches apart and centered 13/32 inch from the top and bottom edge of the panel. The distance between the center of the holes in the lower lip and those of the upper lip shall be 11-3/16 inches. These holes shall accept number ten standard flat-head screws. All external connections to the control box shall be made by means of quick disconnect plug(s) or receptacle(s). The plug(s) or receptacle(s) shall be mounted on the rear of the control box. The overall depth of the control box, plug and cable, shall not exceed 8-1/2 inches.

3.7.6.2 Front panel controls and readback indicators.- All front panel controls shall be combination pushbutton/indicator light switches. Unless otherwise specified, indicators shall be of the same size and shape as the pushbutton switches where only an indicator is required. The front panel layout shall consist of three horizontal rows of five switches and/or indicators each arranged for ease of operation and maintenance. The reset button (or bar) specified in 3.7.6.4.6 shall be located below the mode selection switches. Each switch and indicator light shall be appropriately labeled for the function or functions, it performs.

3.7.6.3 Panel illumination.- Where front panel illumination is required, inverse etched, edge lighting shall be used.

3.7.6.4 Control and readback functions.- All specified interrogator control and readback functions shall be initiated by application of grounds to the remote control lines or microwave link. The control box indicator circuits shall be completed by application of grounds from the interrogator. Controls and readback functions shall be in accordance with the following subparagraphs:

3.7.6.4.1 Local/remote enable switch and no control indicator.- The local/remote enable switch shall be a non-locking pushbutton switch with a red indicator lens labelled "No Control/Local Enable". When this switch is held depressed, a ground shall be applied to the local/remote enable control line. The "NO CONTROL" indicator light shall light when local control is selected at the transmitter site as indicated by the presence of a readback ground from the transmitter site. The "NO CONTROL" lamp shall also be lighted when any of the conditions specified in paragraph 3.7.3 exist. A dimmer shall not be used for this lamp. This control shall be located in the upper left corner of the switch layout.

3.7.6.4.2 Channel selection.- Channel selection shall be accomplished by applying a ground to one of two control lines from one of two locking type, interlocked pushbutton switches labelled "CHAN-1" and "CHAN-2". Channel selection shall be indicated by a white light associated with each switch when a readback ground is present from the selected channel at the transmitter site. These switches shall be located on the left middle and lower left corner positions of the layout.

3.7.6.4.3 Interrogate control and readback.- The interrogate control shall be a locking type pushbutton switch labelled "INT" and, when operated, shall apply a ground to the control line. The indicator light associated with this switch shall have a white lens. This lamp shall be lighted (steady state) when interrogations of the proper power, as determined by the interrogator monitor, are being transmitted and a readback ground from the transmitter site is present. This light shall flash on and off at a rate of approximately once a second when a separate ground from the monitor, indicating a power error, is present. This switch shall be located in the middle row, extreme right of the switch layout.

3.7.6.4.4 Defruit.- When defruiter selection has been achieved as indicated by presence of a readback ground from the transmitter site, a light having a white lens labelled "DEFR" shall be lighted on the beacon remote control box. This light shall be located in the lower right hand corner of the switch layout.

3.7.6.4.5 Range error.- This indicator shall be located in the upper right corner of the switch/indicator light layout. The words "RANGE ERROR" shall flash on and off at a rate of approximately once a second upon receiving a ground from the pretrigger time monitor at the transmitter site. This indicator shall employ red lettering.

3.7.6.4.5.1 Audible range error alarm.- An audible range error alarm shall be included in each control box. This alarm shall sound for a five-second interval upon being energized, and shall be repeated at thirty-second intervals. A switch labelled "MUTE" shall be provided which, upon being operated, shall mute the audible alarm. The audible alarm shall stay muted until the range error alarm condition is cleared, then the circuit shall automatically reset so that a new range error alarm shall actuate both the flashing visual alarm specified in the preceding subparagraphs. The switch shall be a non-locking pushbutton type associated with the range error indicator light.

3.7.6.4.6 Mode selection.- The mode designator selector switches and mode selector switches shall occupy the three center positions of the switch layout. Mode designators X, Y, and Z shall be the top row. Modes 1, 3/A, and B shall be the middle row, and modes 2, C and D shall be the lower row, and the switches shall be labelled accordingly. A white indicator lens shall be associated with each switch. The selection of one mode designator and selection of one mode for remote override of the local mode designator/mode selection at the transmitter site in accordance with paragraph 3.4.2.4

shall be accomplished on not more than five control lines. When no remote control of these functions is activated, all five control lines shall be open (not grounded), and all lights shall be off. The indicator lights associated with these switches shall indicate the selections made as indicated by a readback ground from the transmitter site. These switches shall be spring loaded non-locking type interlocked such that it shall be possible for only one mode designator and one mode to be selected at any one time. It shall not be possible to activate all mode designators or all mode switches at any one time. The interlocking shall be such that a mode designator must be selected before a mode selection can be accomplished. A reset button (or bar) shall be provided below the mode designator/mode select group of switches. When this button is actuated, it shall cancel the mode designator and mode selected and shall reset the selector switches and circuitry such that a new selection can be accomplished by pushbutton selection of any mode designator and mode desired. No one mode designator or mode selector shall have precedence over any other mode designator or mode selector.

3.7.6.4.7 Power on switch and indicator light.- A pushbutton switch with a white indicator light labeled "POWER ON" shall be provided on the front panel of the remote control box. The switch shall control the application of AC power to the control box only. The indicator lamp shall light only in response to a readback ground from the transmitter site denoting that interrogator main power is on. This switch/indicator light shall be located on the front panel so as to not interfere with other operational controls, and such that it will not be inadvertently operated when other controls are used.

3.7.6.4.8 Alternate front panel layout designs.- Alternate front panel layout designs to that specified in 3.7.6 to 3.7.6.4.7 may be submitted for government approval if required for better utilization of available space within the control box. Written approval shall be obtained from the contracting officer prior to the implementation of the alternate approach. Requests for approval shall include detailed information on the proposed design and verification of the need.

3.8 Measurements.-

3.8.1 Metering.- The following circuits, as a minimum, shall be metered:

AC line input voltage
Rectified high voltage
Mixer crystal current
Tuning adjustments in any crystal multiplier chain
IF gain control bias
Rectified low voltage (such as required for solid state devices), including control voltages (3.5.6).

In addition to the above, metering shall be provided for other circuits as required during adjustment and testing. The circuits shall be monitored by a built-in meter or meters. Meters shall indicate in all cases a single maximum or a single minimum without ambiguity such as multiple resonance points or parasitics.

3.8.1.1 Meter selector switching.- Meter selector switching is permissible. However, when meter selector switching is used, the scale multiplier functions shall be chosen and the switch so marked as to allow direct reading of true values from the meter by use of 10 multiples. A separate AC voltmeter shall be provided for reading the AC line input voltage (load side of the line voltage regulator, if such is provided). Also, a separate AC voltmeter shall be provided to read the transmitter high voltage.

3.8.1.2 Elapsed time meter.- An elapsed time meter, General Electric Company's type KT, or equal, shall be provided for each channel and shall record high-voltage circuit operating time.

3.8.2 Test points.- Test points shall be provided for measurement and observation of such voltages and waveforms as are needed to facilitate adequate consecutive checking of the performance of the individual circuit stages and maintenance of the equipment. Except where the functioning of circuits may be adversely affected by long leads, test points shall be conveniently accessible on the front panels. All other test points where possible shall be located on top of each assembly and subassembly. A single connector and a selector switch may be used for several test points, where this method is feasible and convenient. Test points for waveforms shall be provided with jacks for use with synchroscope test leads. Tip jacks shall be provided for the measurement of voltages, with red for positive potentials and black for negative potentials. Where tip jacks are provided for observation of waveforms, they shall be green. All test points shall be identified with a TP number. The TP number shall be in a color which will cause it to stand out from component markings. The connection or disconnection of test equipment to test points in normal use shall not affect the operation of the circuits to which the test equipment is connected.

3.8.3 RF probes.- The RF probe assemblies for the interrogator monitor specified in paragraph 3.4.4 shall be supplied irrespective of whether or not monitors are supplied. In addition, two separate directional couplers with BNC type RF test connectors, as specified in the following paragraphs, shall be provided in each channel of the equipment. The RF test connectors shall be accessible from the front panel of the equipment.

3.8.3.1 Fixed injection directional coupler.- A fixed injection directional coupler for the injection of a signal generator test signal to determine receiver performance shall be provided in the directional antenna transmission line of each channel on the transmitter/receiver side of the antenna transfer switch. The coupler shall have a fixed attenuation of 30 $\pm$ 0.5 dB for incident power; with a source impedance of 50 ohms and with a 50 ohm terminating load, the VSWR shall not exceed 1.2 at a frequency of 1090 MHz. The directivity of the coupler shall be not less than 20 dB. The coupler shall not introduce into the line to which it is coupling, a standing wave ratio greater than 1.05. A nameplate adjacent to the BNC connector located on the front of the equipment shall be provided to indicate the attentuation at 1090 MHz. A curve and adequate explanation shall be provided in

the instruction book to permit the attenuation to be determined to an accuracy of ± 0.5 dB at any point in the band from 1075 to 1105 MHz.

3.8.3.2 Fixed extraction directional coupler.- A fixed extraction directional coupler for extraction of transmitted RF power output shall be provided in the directional and omni-directional antenna transmission lines of each channel on the transmitter side of the antenna transfer switches. The coupler shall have a fixed attenuation of 20 ± 0.5 dB for extracted power, a source impedance of 50 ohms, and a maximum VSWR of 1.2 at a frequency of 1030 MHz when terminated with a 50 ohm load. The directivity of the coupler shall not be less than 20 dB. The coupler shall not introduce into the line to which it is coupling, a standing wave ratio greater than 1.05. A nameplate adjacent to the BNC connector located on the front of the equipment shall be provided to indicate the attenuation of 1030 MHz.

3.8.4 Power metering and VSWR measurement.-

3.8.4.1 Power metering.- A special purpose, built-in, bi-directional peak reading power meter capable of measuring the peak transmitted power of either P1 or P3 on the directional antenna transmission line or P1 or P2 on the omni-directional antenna transmission line directly shall be installed in each interrogator channel with the indicating meter located on the front panel. Selection of either directional P1 or P3 power or omni-directional P1 or P2 power for measurement shall be possible. Through the operation of a switch, the meter shall read the reflected power of the selected pulse for measuring VSWR on the same meter. The meter and its associated circuitry shall be accurate within ± 5% of full scale reading at any power or duty cycle within the operating range of the interrogator. This 5% accuracy applies to measurement of power flowing in both the forward and reverse directions. Power measured shall be taken from the transmitter side of the antenna transfer switches. The directivity of the RF probes for power measurement shall be not less than 26 dB. Complete data on the operation and calibration of the power meter circuits shall be included in the instruction book.

3.8.4.2 VSWR measurement.- The VSWR shall be measured by determination of the ratio of the reflected power to incident power in the transmission lines connecting the transmitter to the antennas. Reflected and incident power shall be measured utilizing the power measuring circuits specified in 3.8.4.1. VSWR shall be determined by normalizing to a reference point by means of an attenuated sample of the incident power obtained from an RF monitor probe and then by monitoring reflected power as sampled from a second RF monitor probe. The VSWR shall be read on either of two additional appropriately calibrated scales on the power meter (3.8.4.1). One scale shall be calibrated from and including 1.10 to 1.60 in increments of 0.05, and one scale shall be calibrated from and including 1.5 to 2.6 increments of 0.1. Complete data on the operation and calibration of the VSWR measuring circuits shall be included in the equipment instruction book.

3.9 Transmitter RF dummy loads.- RF dummy loads shall be provided for terminating the SLS and interrogation outputs of the transmitter. The dummy loads shall be connected to one pole of the antenna transfer switches, in each interrogator receiver and shall automatically be connected to the interrogator outputs by the channel transfer function when that channel is placed in standby status. The dummy loads shall be identical in all respects. Each load shall be capable of operating continuously with a peak RF power input of 5000 watts peak power. The RF dummy loads shall present a load impedance (design center characteristic impedance 50 ohms) such that the voltage standing wave ratio shall be constant and shall not exceed 1.2 over a frequency range of 1025 to 1035 MHz. Precautions shall be taken to keep RF leakage to a minimum.

3.10 Construction.- The interrogator system equipments shall be constructed on pullout drawers (see 1-3.4.8 of FAA-G-2100/1) with panel sizes in accordance with 1-3.4.4 of FAA-G-2100/1. Each interrogator channel will be installed in an identical cabinet rack. Each cabinet rack shall be constructed in accordance with Type I Cabinet Rack requirements of FAA-E-163b with the following exceptions and additions:

(a) Access shall be through the front of the rack only so that the rack may be installed against a wall with other racks abutting against its sides. All internal adjustments, test points, cable connectors, electrical components etcetera shall be fully accessible for servicing with the pullout drawers extended.

(b) The rear mounted door shall not be required; the rear surface of the rack shall be covered with the same material as specified for the side.

(c) Openings for natural (or forced if required by design) ventilation shall be in the bottom and top front panels. The size of the openings shall be determined by the contractor. One top vent plate shall be provided with each cabinet rack.

(d) Only the rear square duct opening shall be provided in the top. The size of the duct shall be as specified. Cable egress shall be through this duct opening. See paragraph 3.3.9.1 for location of antenna output terminals.

(e) Each pullout drawer shall be removable from the rack without requiring mechanical disturbance of any adjacent unit in the rack. Each pullout drawer assembly shall have mechanical stops that lock the drawer in position when fully extended from the rack. Tilt-detent devices with locking positions for servicing shall also be provided on the pullout drawer assembly.

(f) Cable assemblies shall be long enough for the drawers to be fully extended and tilted without removing the unit from operation. All cable assemblies shall be attached to the

drawers (equipment units) through cable connectors.

(g) The various options listed in FAA-E-163b for the Type I cabinet rack are not required.

(h) The front panel of each pullout drawer shall be provided with handles to facilitate its removal from the rack.

3.10.1 Arrangement of equipment units.- Equipment units shall be arranged in each rack in the following top to bottom order:

(a) Ventilation panel
(b) Power panel
(c) Control transfer unit
(d) Blank panel - same size as control transfer unit
(e) Interrogator/receiver unit and the monitor unit
(f) Pulse mode generator unit and the control unit
(g) Line driver unit
(h) Blank panels - C size; necessary number of these panels shall be provided to cover empty front cabinet space
(i) Ventilation panel - same size as the top ventilation panel

Alternate arrangements will be considered upon written request from the contractor, giving detailed information on proposed design.

3.10.2 Connectors.- All connectors utilized in the equipment shall meet the requirements of FAA-G-2100/1, except that the requirements of 1-3.16.3.1, "Mating Connections", FAA-G-2100/1 shall not apply to the antenna output jacks specified in paragraph 3.3.9.1 herein.

3.11 Special tools for maintenance.- All special tools necessary for repair, adjustment, and maintenance, not readily available on the open market, such as printed circuit board extenders, tuning wrenches, spanner wrenches, etc., shall be supplied with each interrogator system.

3.12 Instruction books.- Instruction books shall be in accordance with specification FAA-D-638, and shall be furnished in the quantity specified in the contract schedule.

3.12.1 Trouble-shooting manuals.- Trouble-shooting manuals shall be supplied in accordance with the requirements of the following subparagraphs. The quantity and disposition of the manuals shall be as specified in the contract schedule.

3.12.1.1 Purpose and scope of manual.- This book shall contain all diagrams and illustrations necessary for the isolation and repair of troubles within the interrogator system. It shall be designed for convenient use by maintenance technicians and shall not contain detailed descriptive information. It shall contain copies of the schematic diagrams and system cabling diagrams which are incorporated in the instruction book. In addition, it shall contain simplified, enlarged diagrams of functions designed

to aid in the rapid isolation and correction of troubles within the system Such simplified diagrams shall show separately, in skeleton form, the complete circuitry of such functions as video, trigger, etc., showing all test points in each circuit with the proper waveform for each test point. Separate wiring diagrams, in skeleton form, shall show and identify each plug, pin, terminal strip, meter, test point, switch, relay, etc., for the following circuits: AC power supply distribution, filament supply distribution, DC voltage supply distribution, transmitter high voltage, metering, local control and remote control functions, and other circuits decided upon by mutual agreement between the Government and the contractor. All diagrams shall be arranged to permit simple, straight-forward tracing with functions and directions of travel clearly indicated.

3.12.1.2 Construction and binding.- The trouble-shooting manual shall be designed so that the book can be opened to any desired page and folded back upon itself so as to lay flat for easy reference during maintenance use. A multi-ring binding (circular 1/4" holes on 1/2" centers) shall be provided along the top edge of each page. Covers shall be stiff and durable and shall be made of cloth-covered cardboard or of laminated plastic to permit the book to be folded in a vertical position so as to be self-supporting with the selected page/s nearly vertical. All diagrams shall be flat and not folded. All diagrams shall be extra heavy and serviceable. The scale of schematic and system cabling diagrams shall be at least as great as that used in the instruction books. Diagrams shall be printed on only one side of the sheets. Sheet size shall be 10½ x 21 inches.

3.12.1.3 Review and acceptance.- The procedures for instruction book review and acceptance specified in FAA-D-638 shall apply to the trouble-shooting manuals.

3.13 Reliability/maintainability.-

3.13.1 Reliability.- The transmitter site equipment (see paragraphs 3.1.1 and subparagraphs) shall have a "Minimum Acceptable Mean-Time-Between-Failure" (θ_1) of 1000 hours per channel, where θ_1 is defined by MIL-STD-781B. Reliability goal for the transmitter site equipment shall be 2000 hours MTBF.

3.13.2 Reliability/maintainability.- Interrogator/receiver equipment shall have a single channel availability of no less than 99.6% and an equipment group availability of no less than 99.96%. The MTTR shall not be more than 30 minutes 3.13.4.1.

3.13.3 Reliability program.- A reliability program shall be performed in accordance with Section 5 (omit 5.2.4, 5.3.2 and 5.5.1) of Military Standard MIL-STD-785A modified as follows:

(a) Existing available failure data or predicted failure rates for all types of parts in the equipment design shall be used to calculate equipment reliability. The contractor shall not perform statistical failure tests for the purpose of establishing parts failure rates and qualifying parts for use in the equipment.

(b) For those nonstandard parts for which failure rate is not available, the procedure of paragraph 5.2.3 of MIL-STD-785A shall be followed or a suitable alternate.

(c) The procedures and criteria contained in MIL-STD-756A, Reliability Predictions Procedures, and RADC-TR-G7-108, Reliability Stress and Failure Rate Data for Electronic Equipment, shall be used to establish failure rates when statistical failure data is unavailable.

3.13.4 Maintainability program.- A maintainability program shall be performed in accordance with the requirements of paragraph 5 of MIL-STD-470. All electronic and mechanical equipment and parts shall be designed and fabricated to minimize the skill, and experience, and time necessary to assemble and maintain them.

3.13.4.1 Maintainability prediction.- A maintainability prediction shall be performed in accordance with procedure two of MIL-HDBK-472. The mean-time-to-repair (MTTR) shall not be more than 30 minutes.

3.14 Pulse transformers and crystal units.- Pulse transformers shall be designed and manufactured to meet the requirements of MIL-T-21038 (SHIPS). Crystal units shall be designed and manufactured to meet the requirements of MIL-C-3098.

4. QUALITY ASSURANCE PROVISIONS.-

4.1 General requirements for inspection and tests.- See Section 1-4 of FAA-G-2100/1. The contractor shall provide and maintain a quality control program in accordance with FAA-STD-013.

4.2 Design qualification tests.- The following design qualification tests shall be made under normal test conditions:

Transmitter	Specification Paragraphs
Frequency and tuning	3.4.1; 3.4.1.1; 3.4.1.2; 3.4.1.2.1
Maximum power, PRF and duty cycle	3.4.1; 3.4.1.1; 3.4.1.3
Power output adjustment	3.4.1; 3.4.1.4; 3.4.1.10
Relative pulse power levels	3.4.1; 3.4.1.1; 3.4.1.10
Pulse spacing, delay and jitter	3.4.1; 3.4.1.1; 3.4.1.7
Pulse parameters	3.4.1; 3.4.1.1; 3.4.1.5
Side lobe suppression	3.4.1.9 thru 3.4.1.9.4.1; 3.4.1.10
VSWR and power metering	3.4.1; 3.4.1.6; 3.8.4 thru 3.8.4.2
Transistor and tube change	3.4.1.8
Spurious and CW radiation	3.4.1.11
Interchannel interference	3.4.1.12
Interrogator monitoring	3.4.4; 3.4.4.1
RF probes and directional coupler	3.8.3 and subparagraphs
Interface and antennas	3.3.9.1
External modulation inhibit gate	3.3.9.4.3

Pulse Mode Generator	Specification paragraphs
Trigger processing	3.3.9.3; 3.4.2 thru 3.4.2.1.4
Trigger time monitor	3.4.4.2
Mode characteristics	3.4.2.2; 3.4.2.3
Mode selection and interlace	3.4.2.4; 3.4.2.5
SLS switch gating	3.4.2.6; 3.4.2.6.1
Mode 4 SLS signal processing	3.4.1.9.1; 3.3.9.4.2
PRF stagger/destagger	3.4.2.7; 3.4.2.7.1
Output trigger characteristics	3.3.9.5 thru 3.3.9.5.5

Receiver	Specification paragraphs
Center frequency	3.4.3.1; 3.4.3.1.1
Local oscillator frequency	3.4.3.2; 3.4.3.2.1
Sensitivity and noise figure	3.4.3.3; 3.4.3.3.1
Overall bandwidth	3.4.3.4
Intermediate frequency	3.4.3.5
Image response	3.4.3.5.1
Manual IF gain control	3.4.3.6
Sensitivity time control (STC)	3.4.3.7 thru 3.4.3.7.3
Interference rejection	3.4.3.8 and subparagraphs
External IF signal rejection	3.4.3.9
Fidelity and recovery characteristics	3.4.3.10 thru 3.4.3.10.2.3
Delay	3.4.3.11
Video output	3.3.9.6 thru 3.3.9.6.2 3.4.3.12; 3.4.3.12.1

Power Supplies	Specification paragraphs
Regulation	3.5.1
Bias protection	3.5.2
Ripple voltage	3.5.3
High voltage power supplies	3.5.5 and subparagraphs
Control circuit power supplies	3.5.6 and subparagraphs
Power supply indicators	3.5.7
Primary power	3.5.8; 3.5.8.1

Miscellaneous Functions	Specification paragraphs
Video and trigger remoting	3.3.9.5 and subparagraphs 3.3.9.7; 3.3.9.8 3.4.6 thru 3.4.6.3.2
Control transfer functions	3.4.5 thru 3.4.5.5; 3.6
Control functions	3.7 thru 3.7.4
Readback functions	3.7.5
Remote control box functions	3.7.6 thru 3.7.6.4.7
Metering and test points	3.8 thru 3.8.2
Video and trigger remoting	3.4.6 and subparagraphs

4.2.1 Reliability demonstration.- The reliability requirements of paragraphs 3.13.1, 3.13.2 and 3.4.1.8 shall be demonstrated in accordance with Test Level A-1, Test Plan IV of MIL-STD-781B.

4.2.1.1 Reliability demonstration test plan.- The contractor shall submit for approval to the contracting officer a reliability demonstration test plan which conforms to the detailed requirements of paragraph 4.2 of MIL-STD-781B and the requirements of this specification. The reliability demonstration test plan shall be submitted sixty (60) days prior to start of testing and shall be approved prior to conducting the test.

4.2.2 Maintainability demonstration.- The maintainability requirements of paragraphs 3.13.2 and 3.13.4 shall be demonstrated in accordance with paragraph 5.11 of MIL-STD-470 and Method 3 of MIL-STD-471. Mean time to repair shall not exceed 30 minutes.

4.3 Type tests.- The following tests shall be made while subjecting the equipment to the type test procedures described under 1-4.3.3.2 of FAA-G-2100/1.

Transmitter	Specification Paragraphs
Frequency stability	3.4.1.2
Power output (35 dBw)	3.4.1.3
Relative peak pulse power levels	3.4.1; 3.4.1.1
Pulse spacing, delay and jitter	3.4.1; 3.4.1.1; 3.4.1.7
Pulse parameters	3.4.1; 3.4.1.1; 3.4.1.5
Power metering	3.8.4.1
Side lobe suppression	3.4.1.9.1; 3.4.1.9.2; 3.4.1.9.4.1; 3.4.1.10
Interrogator monitoring	3.4.4 and subparagraphs
External inhibit gate	3.3.9.4.3

Pulse Mode Generator	Specification Paragraphs
Trigger processing	3.4.2.1 and subparagraphs
Trigger time monitor	3.4.4.2
Mode characteristics	3.4.2.2; 3.4.2.3
Mode selection and interlace	3.4.2.4; 3.4.2.5
SLS switch gating	3.4.2.6; 3.4.2.6.1
Mode 4 SLS signal processing	3.4.1.9.1; 3.3.9.4.2
PRF stagger/destagger	3.4.2.7; 3.4.2.7.1
Output trigger characteristics	3.3.9.5 thru 3.3.9.5.5

Receiver	Specification Paragraphs
Center frequency	3.4.3.1; 3.4.3.1.1
Local oscillator frequency	3.4.3.2
Sensitivity and noise figure	3.4.3.3; 3.4.3.3.1
Overall bandwidth	3.4.3.4; 3.4.3.3.1

Receiver	Specification Paragraphs
Intermediate frequency	3.4.3.5
Image response	3.4.3.5.1
Gain and STC	3.4.3.6; 3.4.3.7 and subparagraphs
Video output	3.4.3.12; 3.4.3.12.1

Power Supplies	Specification Paragraphs
Regulation	3.5.1; 3.5.6.1
Ripple voltage	3.5.3
Primary power	3.5.8; 3.5.8.1

Miscellaneous Functions	Specification Paragraphs
Video and trigger remoting	3.4.6 and subparagraphs
Control functions	3.6; 3.7 thru 3.7.3
Readback functions	3.7.5
Remote control and readback functions	3.7.6.4 thru 3.7.6.4.7

4.4 Production tests.- The following production tests shall be made:

Transmitter	Specification Paragraphs
Maximum power and duty cycle	3.4.1; 3.4.1.1; 3.4.1.3
Power output adjustment	3.4.1.4; 3.4.1.10
Frequency	3.4.1.2
Pulse characteristics, delay and jitter	3.4.1; 3.4.1.1; 3.4.1.5; 3.4.1.7
VSWR and power metering	3.4.1.6; 3.8.4.1; 3.8.4.2
Interrogator monitor	3.4.4 and subparagraphs
Side lobe suppression	3.4.1.9 thru 3.4.1.9.4.1; 3.4.1.10
RF probes and directional coupler	3.8.3 thru 3.8.3.2
External inhibit gate	3.3.9.4.4

Pulse Mode Generator	Specification Paragraphs
Trigger Processing	3.4.2 thru 3.4.2.1.4 3.3.9.5 thru 3.3.9.5.5
Trigger time monitor	3.4.4.2
Mode characteristics	3.4.2.2; 3.4.2.3
Mode selection and interlace	3.4.2.4; 3.4.2.5
PRF stagger/destagger	3.4.2.7; 3.4.2.7.1
SLS switch gating	3.4.2.6; 3.4.2.6.1
Mode 4 SLS signal processing	3.4.1.9.1

Receiver	Specification Paragraphs
Center frequency	3.4.3.1
Local oscillator frequency	3.4.3.2
Local oscillator shielding	3.4.3.2.1
Sensitivity	3.4.3.3
Overall bandwidth	3.4.3.4

Receiver	Specification Paragraphs
Intermediate frequency	3.4.3.5
Image response	3.4.3.5.1
Gain and STC	3.4.3.6; 3.4.3.7 and subparagraphs
Interference rejection	3.4.3.8 and subparagraphs
External intermediate frequency rejection	3.4.3.9
Fidelity and recovery characteristics	3.4.3.10 and subparagraphs
Video output	3.4.3.12; 3.4.3.12.1

Power Supplies	Specification Paragraphs
Regulation	3.5.1
Ripple voltage	3.5.3
High voltage power supplies	3.5.5 and subparagraphs
Control circuit power supplies	3.5.6 and subparagraphs

Miscellaneous Functions	Specification Paragraphs
Control transfer functions	3.4.5 thru 3.4.5.5
Video and trigger remoting	3.4.6 and subparagraphs
Control functions	3.6; 3.7 thru 3.7.4
Readback functions	3.7.5
Remote control box functions	3.7.6 thru 3.7.6.4.7
Metering and test points	3.8 thru 3.8.2

4.4.1 Thirty hour system test.- In lieu of reliability testing of production samples and following the tests required in paragraph 4.4, all production transmitter site and applicable indicator site equipments as specified in paragraph 3.1.1 through 3.1.2.2 (hereinafter referred to as beacon system) shall be operated for 30 hours to demonstrate equipment stability for continuous operation. After a ten minute warm up period the beacon system shall be aligned for optimum performance and test measurements taken and recorded. Only front panel controls may be adjusted during this test. Test measurements shall be taken five times during the 30-hour test at approximately 6 hour intervals. During the final 6 hours of each 30-hour test, the beacon system shall be alternately de-energized for one half hour and energized one hour four times. All observations of malfunctioning or instability in the beacon system shall be recorded on test data sheets which will serve as a log or history of the test. The Government representative/s shall be permitted to make any number of entries into the combined Government-Contractor log even if not concurred in by representatives of the Contractor. The beacon system shall not be de-energized during the first 24 hours more than two times and for a total outage of two and one half hours, and then only for the repair of component failures. If either the maximum of two shutdowns or total of 2½ hours is exceeded, it will be necessary to repeat the 30-hour test. All specification requirements specified in paragraph 4.4 shall be met during the 30-hour period without re-adjustment of controls. The reply video signal source/s shall generate not less than two targets, each capable of individual adjustment to any one of the 64 codes (including ident), individual adjustment in range from 1 mile to 200 miles.

5. PREPARATION FOR DELIVERY.-

5.1 General packing requirements.- 1-5.1 of FAA-G-2100/1.

6. NOTES

6.1 Note on information items.- The contents of the subparagraphs below are only for the information of the Contracting Officer. They are not contract requirements, nor binding on either the Government or the contractor, except to the extent that they may be specified elsewhere in the contract as such. Any reliance placed by the contractor on the information in these subparagraphs is wholly at the contractor's own risk.

6.1.1 Equipment options.- The contract schedule should specify the quantity of dual channel interrogator systems to be furnished with the following options, either individually or in any combination:

(a) Interrogator monitor group (3.1.1.2) (3.4.4 to 3.4.4.2)

(b) Line driver group (3.1.1.3) (3.4.6.3.1)

(c) Line compensator group (3.1.2.1) (3.4.6.3.2)

(d) Control box group (3.1.2.2) (3.7.6 to 3.7.6.4.8)

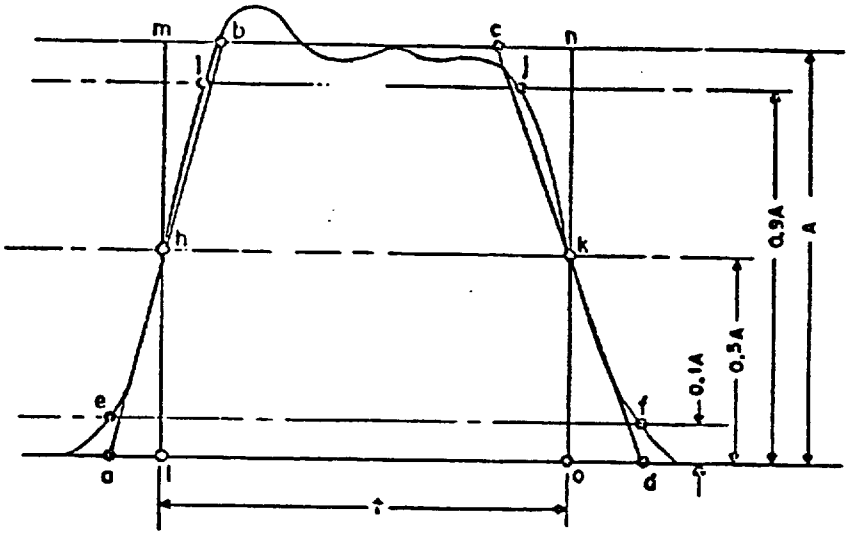

FIGURE 1

CONSTRUCTION OF EQUIVALENT RECTANGULAR AND TRAPEZOIDAL PULSE SHAPES

1. BY SUCCESSIVE APPROXIMATION OBTAIN RECTANGULAR PULSE (AMPLITUDE A) OF AREA EQUAL TO AREA UNDER ACTUAL PULSE AND PASSING THROUGH THE 0.5A POINTS (h.k.) ON THE ACTUAL PULSE ENVELOPE. THIS IS RECTANGLE l m n o.

2. CHOOSE POINTS e f AND i j ON THE ACTUAL PULSE AT 0.1A AND 0.9A LEVELS RESPECTIVELY.

3. THROUGH h DRAW a h b PARALLEL TO A STRAIGHT LINE CONNECTING e AND i.
THROUGH k DRAW d k c PARALLEL TO A STRAIGHT LINE CONNECTING f AND j.
THEN EQUIVALENT TRAPEZOIDAL PULSE a b c d.

NOTE: AREA a b c d = AREA OF RECTANGLE.
= AREA OF PULSE.